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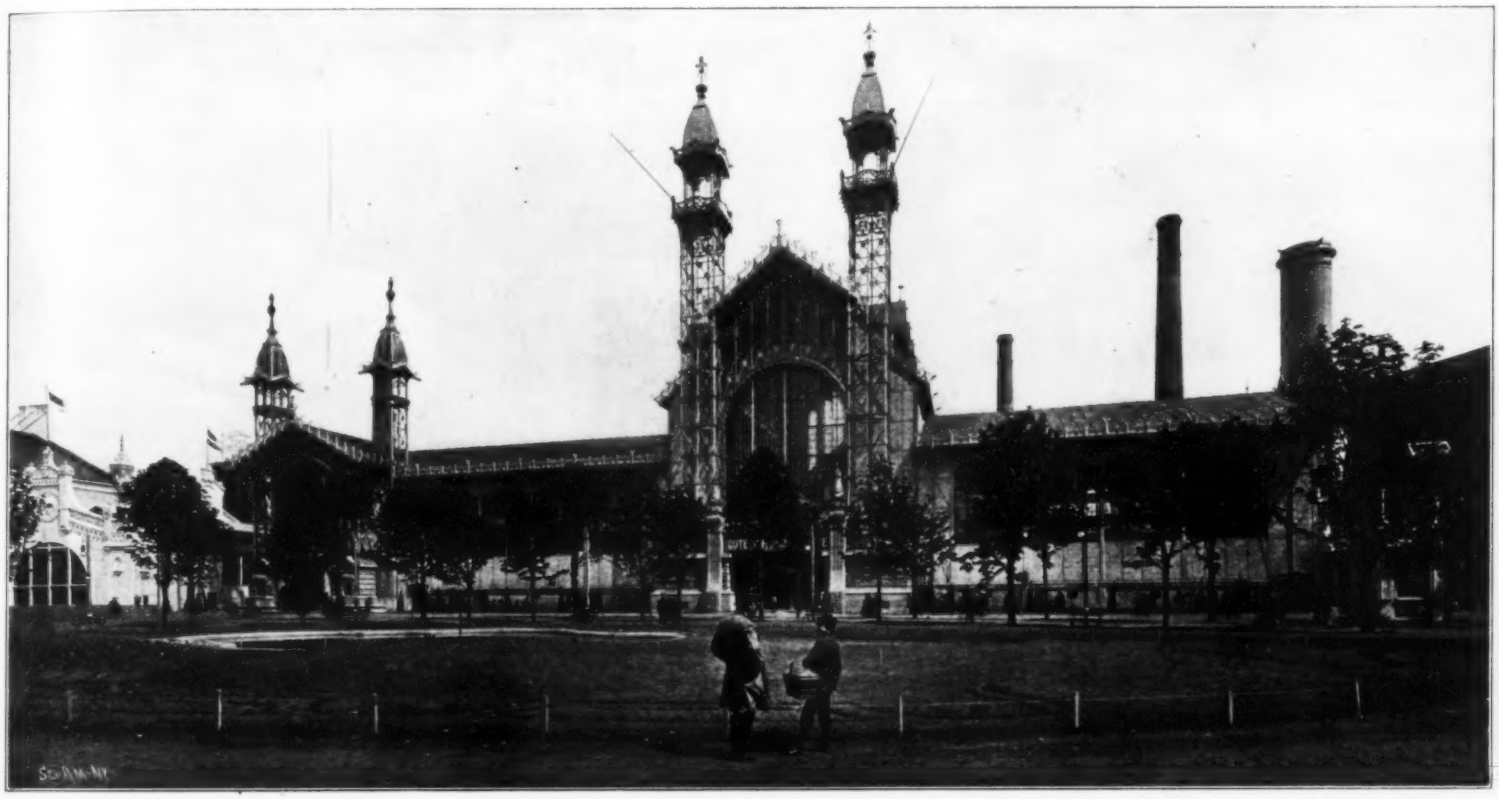
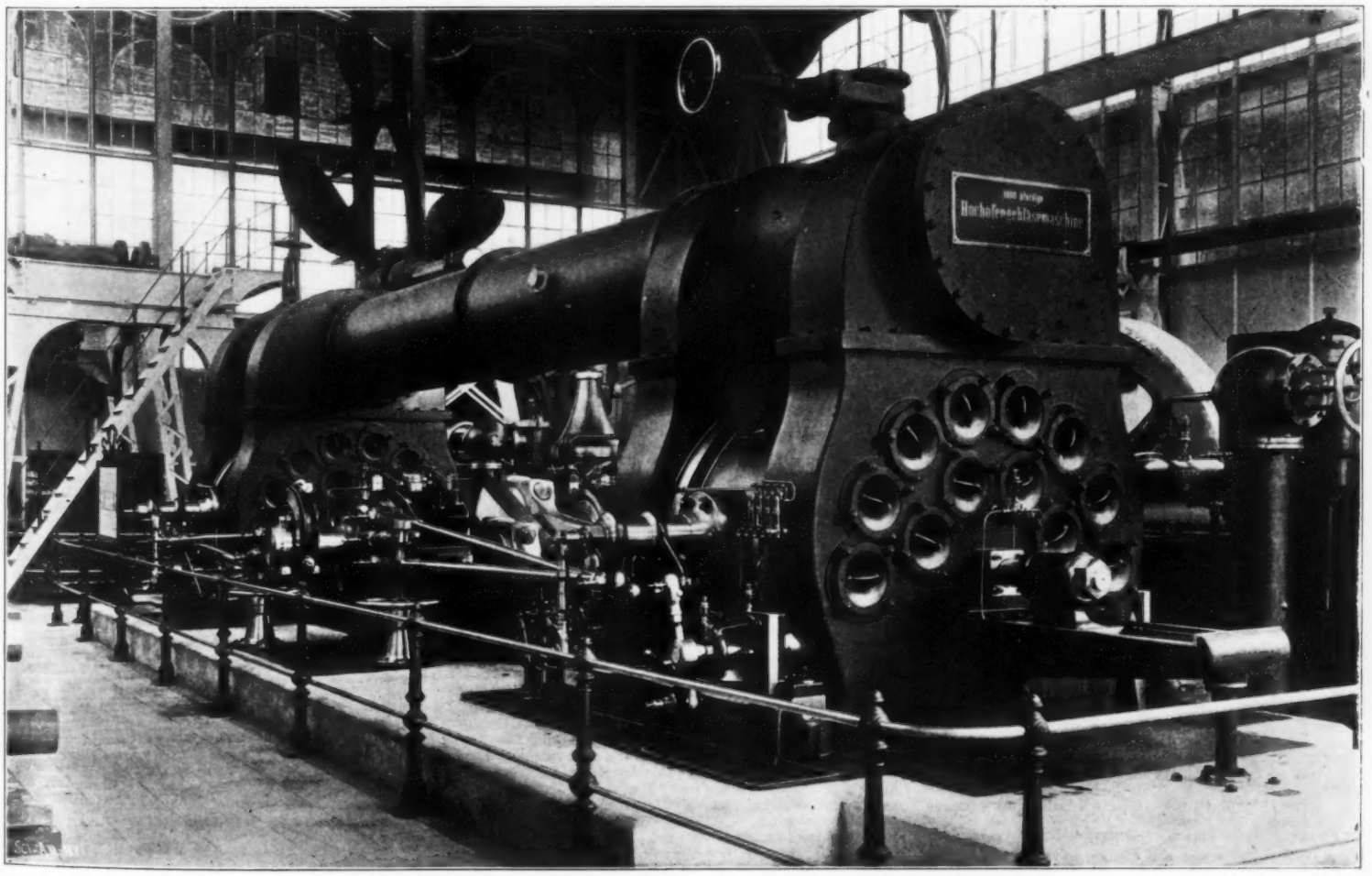


BUILDING OF THE GUTEHOFFNUNGSHUETTE COMPANY.



ONE THOUSAND HORSE POWER BLAST FURNACE GAS ENGINE AND BLOWING ENGINE.

THE GERMAN INDUSTRIAL EXPOSITION AT DUESSELDORF.

THE GERMAN INDUSTRIAL EXPOSITION AT DUESSELDORF.

By FRANK C. PERKINS.

IN passing through the main gate of the Düsseldorf Exposition one enters the Machinery Hall of the Gutehoffnungshütte Building which has large adjoining halls on the right and left-hand sides. On the side walls are hung photographs and plans of various works situated in Oberhausen and Sterkrade, as well as a large bird's-eye view of the district and other pictures and plans showing the development of the Gutehoffnungshütte during its existence. On the right hand side of the hall are exhibited, with the exception of a Riedler express pump, only the produce of the mines, the blast furnaces as well as the steel works and rolling mills with accompanying plans and drawings, while the produce of the iron and steel foundries, of the forge and boiler works as well as of the engineering department are placed in the left-hand side halls; three of the machines at work belong to the last category, viz., the blast engine in the left-hand side hall, the hauling engine in the middle hall, and the Riedler express pump in the right-hand hall.

The double-tandem hauling engine mentioned above has a stroke of 80 inches with high and low pressure cylinders 34 and 48 inches respectively. There are two enormous cylindrical drums on this engine which are 70 inches in width, with a diameter of 26⅝ feet, each with valve link motion and a special steam reversing gear. A net weight of nearly 5 tons may be hauled at an average speed of 69.36 feet per second from a depth of 2460 feet. It is fitted with a steam brake, a falling weight brake, also the necessary safety apparatus, tachometer and depth indicator.

On the left-hand side of the hall there is a large blowing engine for blast furnace having a stroke of 30 inches and two air cylinders 34 inches in diameter. This is coupled to a 1000 horse power blast furnace gas engine, built by the Deutz Gas Motor Company. It takes 1000 cubic feet of air per minute at 135 revolutions and compresses the same to .5 atmosphere. It is fitted with regulating gear whereby it is possible, with the same motor power, but with altered aspiration, to compress the air to .75 atmosphere. The discharge of the air is effected by return valves (Stumpf's patent), the admission by means of cylindrical valve motion.

In the left-hand side of the hall, showing this enormous 1000 horse power gas engine and blowing engine for blast furnaces, there is an electric overhead traveling crane having a span of 54½ feet. Its capacity is 40 tons and it is equipped with a continuous current motor of 25 horse power for lifting and one of 6 horse power for traveling with a speed of 100 feet per minute. It has an auxiliary lifting gear for loads up to 8 tons at a speed of 32 feet per minute. The motors are of the direct-current type, built by the Helios Company of Cologne-Ehrenfeld. Among the other important exhibits in this building are plans and illustrations of underground pumping engines, vertical and horizontal tandem rolling-mill engines, as well as reversing rolling-mill engines and a blowing engine for Bessemer plants.

A most excellent exhibit may be noted showing axle and wheel-tire manufacture, the group including among many other articles, the rough ingots, a pressed ingot for wheel tires, a pressed and punched ingot for wheel tires, a forged tire finished and seven cooled wheeled tires of an internal diameter of 1400 to 2000 millimeters. Another group represents a construction of wheel centers and wheel disks, which another shows sets of wheels and axles for tramway use, while a third group shows the products from the plate mills.

There are also in this building excellent exhibits of bridge-building material as well as products from the steel foundry, iron foundry, boiler works and forges of this great industry.

During the present summer the German National Art Exhibition is being held at Düsseldorf on the Rhine, and in conjunction with it an industry and trade exhibition for Rheinland and Westphalia. Many of the buildings of this exposition are of most excellent architectural design and the grounds and decorations are arranged in the most pleasing manner, the electrical effects being particularly fine. Among the interesting exhibits should be mentioned those of the Gutehoffnungshütte, Actienverein für Bergbau und Hüttenbetrieb of Oberhausen II., Rheinland. In the main machinery hall of the Gutehoffnungshütte Building, this firm exhibits an enormous vertical triple-expansion steam engine of 3000 horse power, directly connected to an alternating-current generator and a direct-current exciter, the latter dynamo being mounted at the end of the engine shaft, outside of the main alternator bearings. This high-power engine was constructed for the electric central station at Essen. The diameter of the high-pressure cylinder is 33 inches and the low-pressure cylinder 82 inches, while the intermediate cylinder measures 56 inches in diameter and the length of stroke 48 inches. The speed of the engine is 94 revolutions per minute and the low-pressure cylinder is constructed with cylindrical valve gear, while the high and medium-pressure cylinders are built with Gutermuth's distributing valve motion.

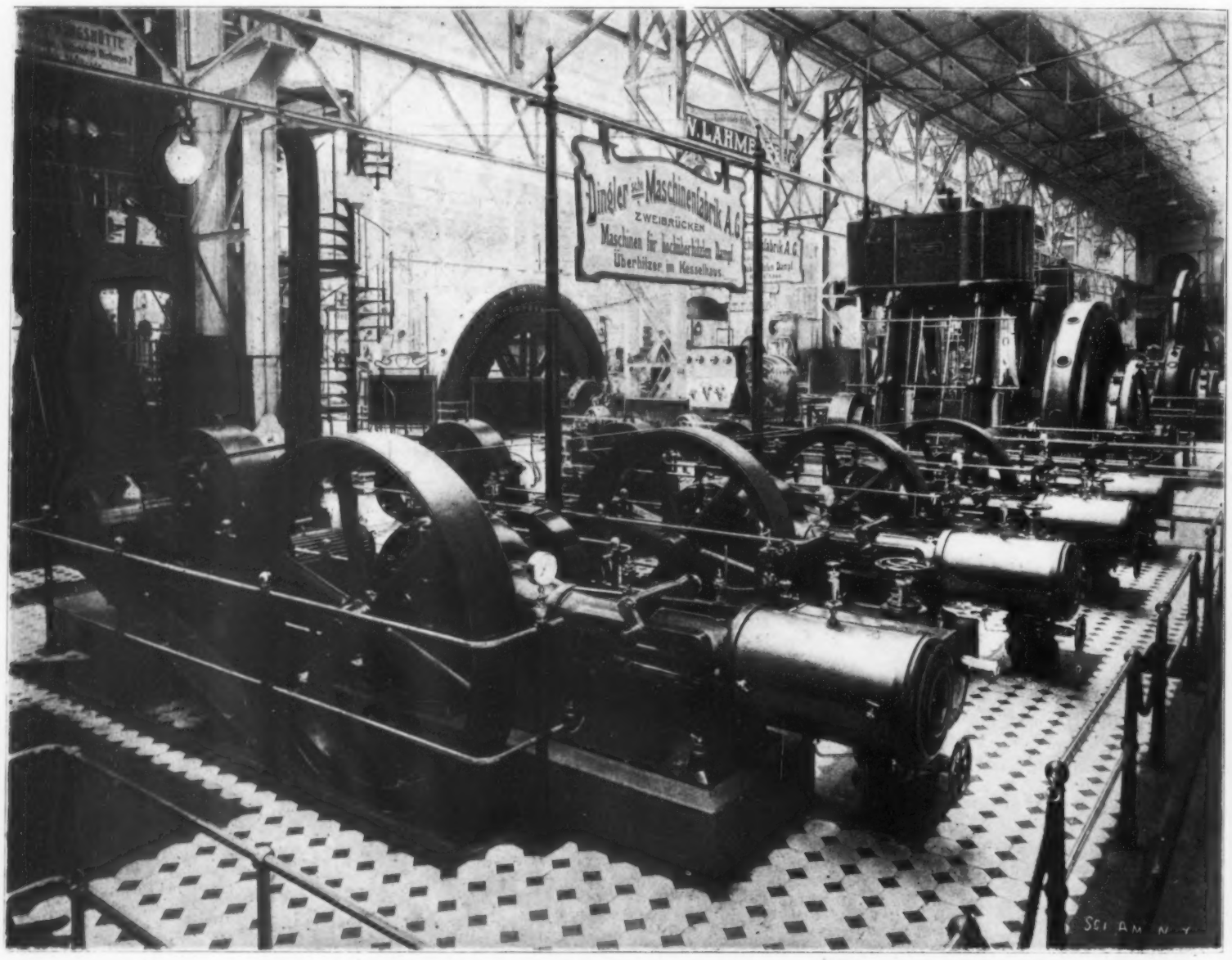
At the right-hand side of the hall an electric Riedler express pump is shown, with two simple-acting plungers, each 7.4 inches diameter, with a stroke of 10 inches in length. At a speed of 300 revolutions per minute, this pump raises 8.2 feet of water per minute to a height of 1968 feet. It is driven by a three-phase motor of 450 horse power, operating at a potential of 2000 volts and a speed of 200 revolutions per minute.

The engine and generator exhibits of the Düsseldorf Exhibition, while not as extensive as at the Paris Exposition, are of great interest and well worthy of careful study and consideration. The 2000 horse power twin tandem engine built by the Maschinenfabrik Grevenbroich, driving the Helios polyphase alternator, is used largely for lighting the exposition.

The four engines in the foreground of our general view are used for driving direct-current generators by belt transmission. They are of 37, 47, 60 and 76 horse power capacity and the Lahmeyer dynamos, so driven, are used for supplying exciting current for the large alternators located in that section of the exhibition building.

These engines, as well as the 600 horse power vertical compound engine seen in the background at the right, are supplied with superheated steam at 350 deg. by a special direct-fired superheater in the boiler room. This superheater was constructed by the Dinglerische Maschinenfabrik Actien-Gesellschaft of Zweibruecken, and has a heating surface of 150 square meters, supplying per hour 6000 kilogrammes of superheated steam at 350 deg. and at from 10 to 12 atmospheres pressure.

The large vertical engine seen in the background of the illustration of interior of Machinery Hall, was constructed by this firm and when supplied with superheated steam and operating at a speed of 120 revolutions per minute, develops 600 horse power. The cylinders of the engine are 600 millimeters and 950 millimeters in diameter and the stroke is 700 millimeters in length.



GENERAL VIEW OF THE MACHINERY HALL AT THE DUESSELDORF EXPOSITION.

In the Machinery Hall at the Industrial and Trades Exhibition, there are a number of high-power engines in operation, both vertical and horizontal types, directly connected to electrical generators and it may be of interest to note some of the details of construction of these machines and their accessories.

Among the larger engines shown is one of 2000 horse power, constructed by the Maschinenfabrik Grevenbroich of Grevenbroich (Rheinland), located under group IV. This engine is of the twin compound-horizontal type and has on each side a high-pressure cylinder (8½ inches), 725 millimeters in diameter, and a low-pressure cylinder (43¼ inches) 1100 millimeters in diameter, and a piston stroke common to both of (51¼ inches) 1300 millimeters.

This horizontal engine has a speed of 72 revolutions per minute and is directly coupled to a three-phase alternating-current generator built by the Helios Electricitäts Actiengesellschaft, of Ehrenfeld, Cologne, Germany, which supplies a large proportion of the necessary electric current for the exhibition.

The engine develops 2000 effective horse power when worked condensing with the cut-off at 25 per cent stroke and a working pressure of 10 atmospheres in the high-pressure cylinders. Siemens-Martin steel is used in the construction of the crankshaft, and it is bored throughout its entire length, and the wrought-iron cranks are shrunk on warm and counterbalance weights are provided in order to partially compensate the disturbing influence of the inertia of the rods. The large main pedestals which carry the crankshaft are cast in one piece with the Corliss frames, and the frames have tubular guides carried by the foundation throughout their length. There are four parts to the steps of the main bearing, and the crank and crosshead pins are in two parts, and all the bearings are adjustable, while the main and crankpin bearings are lined with white metal. The crosshead pin bearings are of bronze, and the crankpins are of nickel steel. The crosshead pins are of crucible steel and the crossheads are of cast steel polished and provided with long cast-iron guide shoes.

The piston rods of this 2000 horse power German engine are of Siemens-Martin steel, and are all of the same diameter (6½ inches) 160 millimeters, and are not carried through the rear cylinder covers.

The oil distribution and devices for catching the waste oil are so arranged that all the lubricating apparatus for moving parts are fixed and may be attended to and replenished at any time while the engine is in motion. Sight-feed drop lubrication is used for all parts not subjected to steam pressure, while Mollerup's oil pumps are used for lubricating the parts under pressure.

The steam pistons are hollow and are formed so as to support their own weight. They are secured to the rods by means of cones and nuts, and are made of cast-iron. Metallic packing is employed for making the piston rods steam-tight, and in order to avoid canting the gland when tightening the packing the glands are formed with teeth engaging into a toothed annulus whereby all are turned simultaneously.

Distance pieces are used to connect the high-pressure cylinders to the low-pressure cylinders, and the latter are directly connected to the Corliss frames, and the steam cylinders have steam jackets, the whole being cast in one piece.

Direct live steam is used for heating the high-pressure cylinders and receivers, and working steam through the main stop valves of the engine is used for heating the low-pressure cylinders, and each cylinder is provided with escape valves combined with drain cocks.

The steam is lubricated before it enters the valves to the steam cylinders, and the surface over which the piston runs is directly lubricated by means of oil distributors and a Mollerup pump. To catch the oil which runs off there are provided guards of cast-iron or planished sheet metal, and they are so arranged that the waste oil splashed about is securely caught, and they permit the moving parts to be observed.

Each side of the engine may be worked independently, and the cock levers and stop valve are all accessible from one position. By means of an oblique-lying spindle the main stop valves are operated, this spindle being brought into connection with the screw spindle of the valve by bevel gear.

The lubrication of the crankpins is accomplished by means of a tube fitted into the head of the crankpin and provided with an oil cup which revolves concentric and coincident with the axis of the shaft, from which cup the oil passes out by centrifugal force to the crankpin.

In the four cylinders the steam distribution is effected by means of balanced double-headed valves, four being used on each cylinder. The admission and exhaust valves on the high-pressure cylinders are worked by positively closing valve gear designed by Maschinenfabrik Grevenbroich, while the valves of the low-pressure cylinders are worked by cams which are adjustable.

Bevel gear is used for driving the valve-motion shafts, and the shafts are provided with expansion couplings in order to compensate the longitudinal expansion of the steam cylinders. For the lubrication of the crossheads each pin is provided with an oil cup having a metal wiper. The fixed drop-feed lubricator is provided with a socket furnished with a fine brush, on which the oil from the drop-feed lubricator flows, and then as the wiper on the crosshead pin lubricator comes opposite the oil is wiped off the brush and carried with the crosshead. The guide shoes are provided with oil paths and equipped with scrapers of copper below, and of felt above, by means of which the oil is very efficiently distributed over the curved surface of their path.

A device is arranged with the spring-loaded governor for varying the number of revolutions, being mounted on distance pieces between the low and high-pressure cylinders, and is driven by helical gear from the valve shafts. A hand lever is mounted between the valve gear and the governor, and the former may be thrown out of action and further admission of steam cut off instantaneously in case of any accident.

Above the main pedestal cover there is an oil reservoir from which the oil passes into the bearing proper by means of tubes with an adjustable visible drop feed. The steps of bearing, as well as the shaft journal, have appropriate oil paths formed in them to insure a proper circulation of the oil, while the oil which flows away from the pedestal is caught in receptacles which are provided with fine sieves in order to keep out the dust. The oil is pumped back into the oil reservoirs from these receptacles by small oil pumps driven by chain wheels from the valve motion shafts. The reservoirs are each furnished with a fine sieve and diaphragms of felt to catch the impurities, and in order that the thick deposits on the bottom may not be allowed to enter the pedestal the outflow is not taken from the deepest point. This arrangement of oil circulation provides a very lavish lubrication, and as the oil is used over and over again it requires renewal only at long intervals.

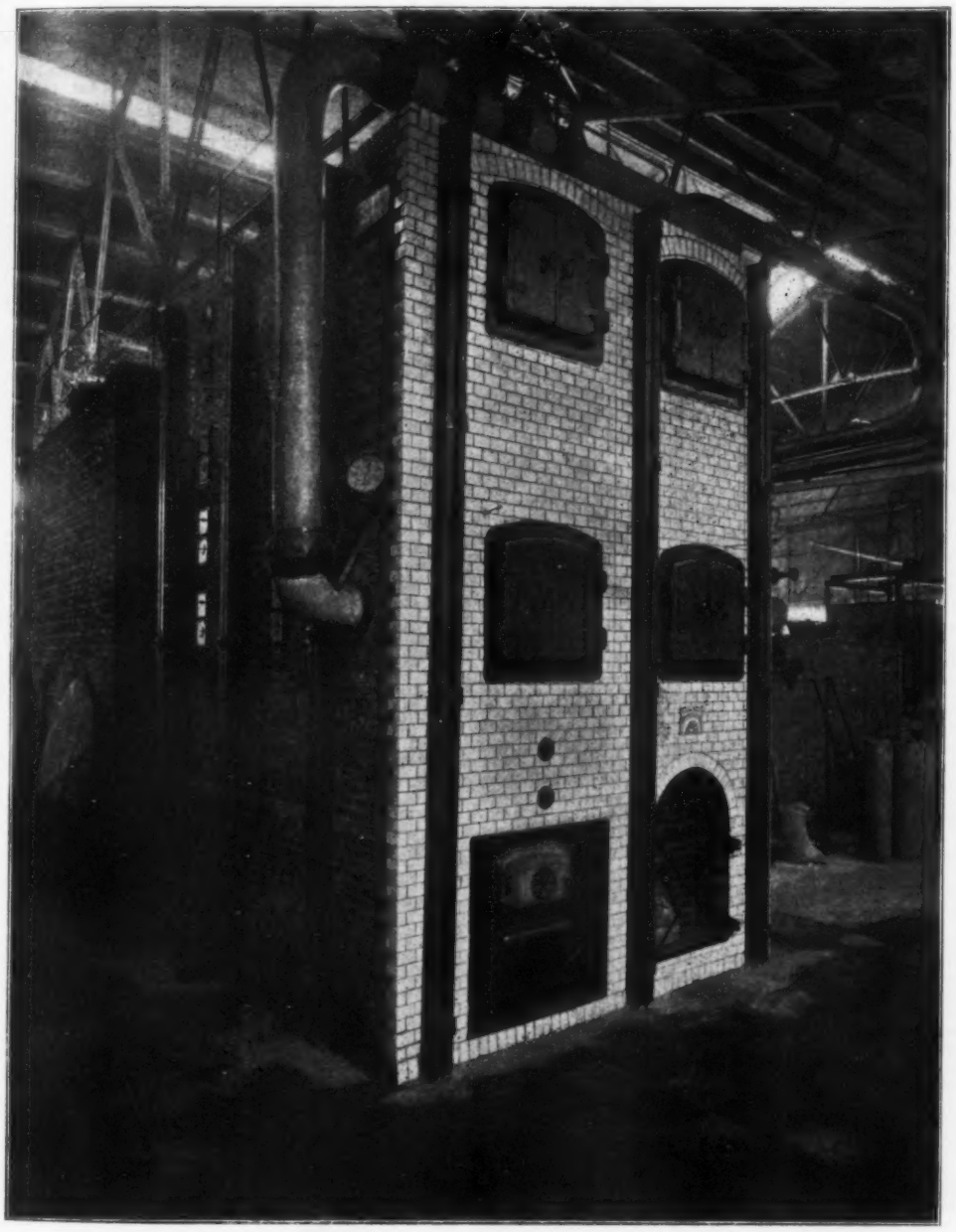
Another large engine on exhibit is a tandem compound rolling-mill horizontal engine constructed by the Duisburger Maschinenbau-Actiengesellschaft, vormals Bechem & Keetman, of Duisburg a. Rh. Germany. This engine has a capacity of 1100 horse power, under a normal speed of 100 revolutions per minute, and with a working steam pressure of 10 atmospheres. The high-pressure cylinder is 28½ inches in diameter, and the low-pressure cylinder has a diameter of 42 inches. The flywheel of the engine weighs 53 tons and is 25.584 feet in diameter.

The Maschinenfabrik Grevenbroich, of the Rhine Province, exhibits in the main steam generating station of the Exposition an interesting design of water-purifying apparatus. It has a duty of 4444 imperial gallons (20 cubic meters) per hour which supplies purified water for half of the boilers exhibited. The water used for purification is that coming from the condensing plant (hot well water from injection condensers).

The apparatus is constructed in the form of a press, and is horizontal, containing in itself the heater, filter and precipitating apparatus, the three parts being mounted together in one frame in such a manner that adjoining the fixed head a number of heater elements in the form of plates, each having a special inlet for steam and for water, are arranged in sequence.

The precipitation tank then comes, which forms a chamber for the calcareous sediment, and the filter elements join directly onto this. These contain a channel which takes up the filtered water and conducts it back through the precipitation chamber and the heater elements to the fixed head again.

In the operation of this water-purifying apparatus an independent vertical compound steam pump takes the water to be purified from a collecting tank and forces it through the water purifier, and it flows first into the heater and then passes into the precipitation tank above where the lye is added to it in a definite proportion, according to the quantity and quality of the water. The water along with the precipitated matter then passes out from the precipitation chamber direct into the adjoining filter chamber, whence, after being purified, it is led into a reservoir for pure water, from which the feed pumps draw the water directly into the boilers. The apparatus is also constructed in vertical form with heater, lye vessel and gravel filter. The water to be purified is heated by either exhaust steam or live steam, and the details of construction may be noted in the accompanying drawings.



DIRECT-FIRED STEAM SUPERHEATER AT THE DUESSELDORF EXPOSITION.

THE CAPE TO CAIRO RAILWAY.

WHEN the Duke and Duchess of Cornwall and York visited South Africa, they found a "train de luxe" in use on the Cape government line. According to the last annual report of the directors of the British South Africa Company, the train de luxe will soon be running between Cape Town and Bulawayo (1500 miles).

In Rhodesia, railroad building is progressing rapidly, although the Boer war interfered with the transportation of construction and equipment material from the south. Meanwhile, the Beira-Salisbury line has been extended southward and a junction formed with the main line at Bulawayo. It was originally intended that the line from Bulawayo via Gwelo to Salisbury should constitute the first section of the main line northward, toward Lake Tanganyika, and that the Zambesi should be crossed in the vicinity of Kariba Gorge. Later explorations, and particularly the discovery of the Wankie coal beds, have led to the adoption of a route farther to the west, including the crossing of the Zambesi at Victoria Falls. The railway is due to reach the coal fields during the coming autumn and Victoria Falls before the end of 1903.

On April 14, 1902, an agreement was signed in Brussels which would seem to constitute an important step toward the realization of the late Cecil Rhodes' "dream." Under the Belgian contract, the German route is abandoned, and the Cape to Cairo Railway will be carried through the Kongo Free State to the upper waters of the Nile. Instead of heading for Lake Tanganyika and German East Africa, the line will continue due north of Victoria Falls to the Kongo border, and thence via Katanga to Lake Kasali, which is the most southerly navigable point on the Lualaba (one of the principal reaches of the Kongo). Approximately, the distances to be covered are: Bulawayo to Victoria Falls, 300 miles; Victoria Falls to Lake Kasali, 700 miles. From Stanley Falls on the Upper Kongo, a railroad will be built to Mahagi on Albert Nyanza (480 miles), thus supplying the missing link between the Cape and the Egyptian railway nets. Such is the scope of the concession which Mr. Robert Williams obtained last month from the King of the Belgians. This project does not, however, necessarily replace the original central line through German territory, as planned by Mr. Rhodes and the German government. In fact, it is quite likely, if the proposed railroad be built from the coast of Dar-es-Salaam, the capital of German East Africa (either through subsidy granted by the Reichstag or by private capital under State guaranty), that the original Cape to Cairo scheme via Tabora will be realized. Both lines may astonish the world before many years as full-fledged realities. All maps of Africa more than six months old are obsolete, because history is being made so rapidly in those regions.

By joining at Lake Kasali the Kongo Free State river and railroad system, the Cape to Cairo Railway would secure a western feeder, via Leopoldville and Matadi, of the highest importance. On the eastern side, there are already two feeders in waiting, viz., the Beira-Mashonaland Railway (350 miles) and the Mombasa-Uganda Railway (660 miles). For the latter, rails had been laid last Christmas as far as the Victoria Nyanza. Another prospective eastern feeder is the proposed Suakin-Khartoum line, the construction of which via Berber (350 miles) during the next two years seems to have been recently decided upon by the Sudan government. This will make Suakin on the Red Sea, instead of Alexandria, the chief port of the Sudan. To these eventual feeders may also be added the French line from Djibouti through Abyssinia via Harrar to Addis Abeba, the capital of King Menelik's dominions (430 miles), and perhaps to Fashoda, an enterprise which, by act of the Chambers, was recently granted financial support from the government of France.

In the development of the Dark Continent, as Africa is yet called, the United States is not at present playing a conspicuous part. Stanley's momentous work in the seventies has not been followed up by his quondam countrymen; nor is our trade with Africa, except Cape Colony, of relative consequence. It is to be hoped that more attention will be paid by our manufacturers and exporters to the African markets, and concerted efforts made to reach them. Cape Colony, with its imports of $84,000,000, and Egypt, with its imports of $70,000,000, bought, in 1900, $8,600,000 and $1,400,000 worth, respectively, from the United States. Even at that rate, there is ample room for improvement; but our showing is much less satisfactory when we consider the markets of Abyssinia, the Sudan, the Congo Free State, Rhodesia and other growing nations and protectorates in the interior. Rhodesia alone imported during the year ended March 31, 1901, goods to the amount of $10,267,518. These figures indicate only faintly what may be expected in five or ten years. Rhodesia is eight and one-half times the size of Great Britain, and its natural resources include rich deposits of gold and of coal, besides fertile lands and forests. The closing of hostilities in South Africa will give a tremendous impetus to agricultural, industrial and commercial activity throughout the continent.

A CONTRACTOR'S APPLIANCE.

A device which will without doubt commend itself to contractors and others, has just been introduced by the Hardy Patent Pick Company, Limited, of Sheffield. The device, says the Engineer, is an automatic slip-hook, which is applicable to cableway boxes, ballast, and all classes of locomotive crane boxes; also to tipping tubs and to loading and unloading buckets of all descriptions. It is also intended for the automatic release of large stones, iron, or blocks of any material. It is arranged to form a part of one of the three lifting chains attached to the box or tub. As shown in the engraving, it is in the position it assumes when carrying weight. The few links of chain at the top form part of the chain going to the crane hook, those at the bottom going to the object being lifted. When in this position, and when the weight is on, the curved lower arm is so pressed against the inner surface of the hole in the horizontal lever or handle that the spring attached to the top of this fails to draw it upward. Immediately, however, the load is taken off by the box or object being lowered touching the ground, the lower chain gets slack and the horizontal lever flies upward, releasing the curved bottom arm as it does so. The release is brought about without assistance, and entirely automatically. Since the discharge of a box, say, does not take place till the box is actually on the ground, and then by the gradual removal of the box, it can well be understood that there are grounds for the makers' claim that there is no tipping action, and that, therefore, dust and breakage are reduced to a minimum.

A NEW SAFETY SIGNAL SYSTEM FOR REPEATING RAILWAY DANGER SIGNALS VISIBLY AND AUDIBLY IN THE LOCOMOTIVE CAB.

For some time past patrons of the State system of railways have been astonished to see in operation a locomotive carrying upon the roof of its cab an inclined pole provided with a bow which somewhat resembles that of the trolleys of certain electric lines. Electric propulsion, however, is not even under experiment upon the State railways, and, moreover, an examination of the fine wire that forms the bow shows at once that it would be impossible for it to withstand the friction upon an overhead wire, even at reduced speeds. The inclined pole and bow are the result of experiments that have been carried on successfully with an invention of Capt. Netter, of the corps of engineers, and the object of which is to reproduce in the engineer's cab the signals seen along the track; we should say the setting of the signals, since it is this in reality that has a primordial importance and that ought never to escape the engineer.

Evidently and theoretically, all that is necessary is a disk of two colors (red and white in France) turned at right angles with the track, so that the engineer may know that the way is not clear and may bring his train to a standstill; but, in reality, it frequently happens that the engineer runs into a block that is already occupied, and that an accident occurs as a result.

When the cause of the accident is afterward sought and it is desired to fix the responsibility for it, it is in most cases very difficult to ascertain with certainty whether the signal was not properly set, whether it was so set and the engineer knowingly disregarded it, or whether he went ahead because of the material impossibility of seeing it, especially in the case of a fog. At all events, it may be readily seen how desirable it would be if the passage of a signal by a locomotive could cause some sort of an acoustic device to resound automatically upon the engine itself and under the eyes of the engineer. In such a case, the latter would no longer have an excuse to offer should he pass such signal.

Inventions in this line have been manifold, and proportionate to the serious interests involved. We cannot pass all of them in review, but shall merely say that most of them present the drawback of submitting the transmitting part to an abrupt contact with the receiving part arranged upon the engine, and since such contact always occurs at quite a high speed, it produces a genuine shock that soon puts the apparatus out of service. The Compagnie du Nord has devised what is vulgarly called a "Crocodile." This consists of a girder, copper covered, and placed between the rails, which by means of a commutator connected with the signal, is made to receive current from a battery placed beside the track. The locomotive carries a metal collecting brush, which conducts the current to

AUTOMATIC SLIP HOOK.

it and thus causes a warning whistle to sound. Since the contact takes place at a distance of 200 yards back of the signal, the engineer has time to stop his train. This arrangement, however, is based solely upon an electric contact, which is quite costly and capable of failure under certain conditions of the atmosphere.

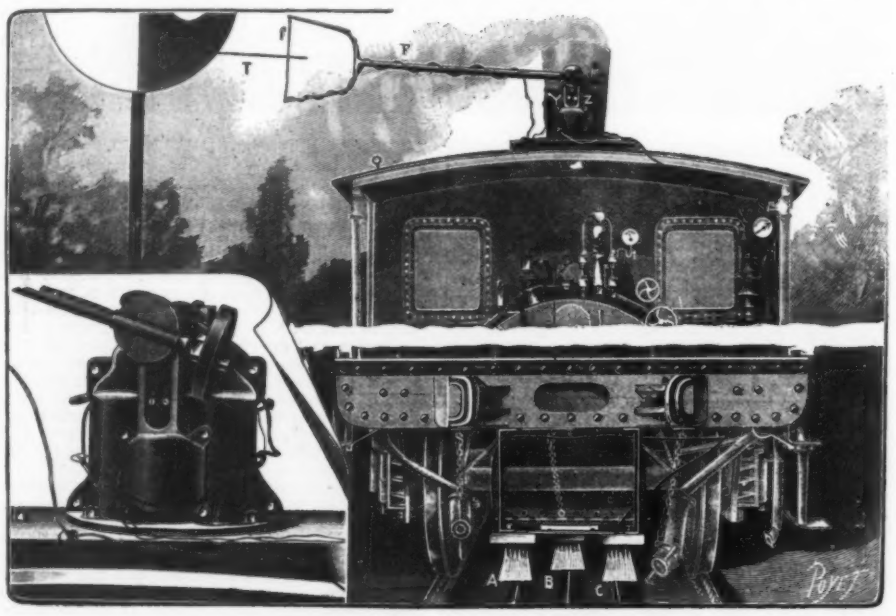
It has occurred to some inventors to utilize an obstacle placed beside the track, in order to obtain a blow that breaks a fragile intermediate object. In such a case, the inconveniences of the blow are no longer to be apprehended, since, on the contrary, it is made use of and becomes an essential condition of the operation of the system. However, up to the present, Capt. Netter's invention is the only one that fully meets all the requirements of such a combination, since the blow is always effected without injury to the intermediate parts and without straining or damaging the signals in the least. Electricity plays a part in this apparatus also, but under conditions such that all the circuits are upon the engine, and that consequently no derangements could occur that would pass unperceived.

To each disk of the signal is riveted a metal rod, *T*, which, together with the disk, forms a right angle with the track when the signal is set. This rod is so arranged that a very fine copper wire, *f*, carried at the end of the bow-pole, *F*, comes in contact with it if an engine passes the signal when it is set for danger. This wire is extremely fine and the breaking of it causes so slight a shock as not to damage the disk. It is scarcely necessary to remark that the wire-breaking rod does not protrude far enough to hit the cars, but yet is sufficiently long for the locomotive pole to need only a slight overhang beyond the side of the cab. A continuous electric current, taken from a small 12 ampere hour, 20 volt storage battery arranged at the side of the engineer's cab, passes through the wire. If the latter breaks, the magnetic attraction that is exerted upon a sliding vane ceases and the vane falls at *V* under the very eyes of the engineer, who is duly warned thereby that he has passed a signal. Moreover, the vane itself establishes a contact, and a current from the accumulator causes a whistle arranged at *S* to blow. The optical signal is thus completed by an acoustic one; and, since a wire wound around the conductor's bell-cord communicates with another whistle placed in the baggage car, the conductor also is warned that a signal has been disregarded. There is, therefore, no longer any excusable error possible, and the culpability may be surely fixed if the train continues on its way. The whistle will continue to operate until the passage of the current has been reestablished and the vane readjusted by putting a new copper wire in place.

Such, then, is the essence of this ingenious invention. In the operation of a railway, however, there are circumstances in which it is sometimes necessary to pass a danger signal. In such a case, in order that the wire may not be broken uselessly against the rod, *T*, Capt. Netter has arranged a handle at *M*, by means of which the engineer can send the current from the accumulator into a series of electro-magnets, the object of which is to lower the fork, *F*, so that it will no longer hold the wire in the path of the rod, *T*. But in order that the engineer might not take the liberty of passing a danger signal when the necessities of the case did not demand it, the apparatus was arranged so that the lowering of the pole at once involves the setting in action of the two whistles in consequence of the rotation of a copper disk operatively connected with the axis of rotation of the pole, and which is provided at a single point with an insulating segment of ebonite. As long as the pole is raised, the ebonite segment interrupts the passage of the current that sets the whistle in operation, and, immediately after the rotation begins the copper part of the disk comes in contact with the conducting brush and allows the current to pass.

The handle, *M*, might be used for lowering the pole every time the train passed under a bridge; but, since this would have required too much attention on the part of the engineer, it became necessary to devise the automatic combination of electro-magnets above mentioned. These are electros of the Guenée type. They form two groups, *Y Z*, each comprising a small and a large electro, and are arranged upon the roof of the cab, at the point at which the pole is fulcrumed. The entire arrangement is scarcely more than 7 inches in height.

Just before the locomotive runs under a low bridge it passes over a rail placed between the running rails in such a way that a brush, *C*, arranged beneath and to the right of the engine rubs against it, thus completing the accumulator circuit through the small electro-magnet of the group. The armature of the magnet at once rises and touches a small rod with a spring forming a contact. This has the effect of sending current through the large electro-magnet of the same group. Attracted upwardly, the armature of the latter, which is fastened to one end of a rod that is connected with a pulley keyed upon the axis of rotation of the pole, raises the end of the rod and, consequently, rotates the pulley and pole sufficiehtly to lower the latter the required distance. The pulley is held in its two positions by a special bolt, which is withdrawn by an electro-magnet when the pole is about to be lowered. The pulley has but two holes into which the bolt can enter, which correspond respectively to the raised and lowered position, the pole being fixed in the latter when the motion of the rod above mentioned has terminated. As soon as the engine has passed beyond the live rail the current no longer flows and the armature, etc., falls back under its own weight, the pole remaining in its lowered position and bolted. As soon as the engine emerges from beneath the bridge, it passes over another rail which, in this case, is to the left; and by means of another brush, *A*, and the second group of electro-magnets, an exactly opposite operation occurs, causing the previously unbolted pole to rise to its



NETTER'S RAILWAY SIGNAL REPEATER.

normal position. Since the whistles blow in the engineer's cab and in the baggage car every time that the pole is lowered, it is possible for the conductor to know any irregularity that may occur.

Capt. Netter, with the object in view of warning the engineer slightly in advance that he is approaching a danger signal, has provided his system with a third brush, *B*, placed under the center of the engine and rubbing against a third rail placed about 200 yards from the signal and connected by a wire with a commutator situated at the signal itself. According to whether the way is obstructed or clear this commutator connects the wire and rail with the ground or maintains the insulation. In the first case, the current passes and blows the whistles, while in the second nothing occurs.—For the above particulars and the illustrations, we are indebted to La Nature.

ELECTRIC COAL CUTTER.

THE illustration represents an electrically-worked coal-cutting machine manufactured by Mavor & Coulson, Limited, of Glasgow. It is known as the Hurd bar machine. It consists essentially of five parts—namely, the cutter bar, the gear head, the motor, the switch box, and the hauling gear. The cutter bar is tapered—as will be seen from the engraving—and is provided with a spiral groove on its outside, which acts as a worm conveyor, bringing the coal cuttings out from the holing. The cutters are secured in holes drilled in this cutter bar. On the inner end of the bar renewable thrust rings are fitted, and by means of these a reciprocating motion is imparted to the bar. The gear head contains a double bevel wheel, which drives through a 2 to 1 reduction the pinion of the cutter bar, and is itself driven by a pinion fixed on the end of the motor shaft, which is made long enough to project into the gear case. In the lower part of the gear case is a rack which, in conjunction with a pinion, provides for turning the lower part of the gear head, which carries the cutter bar round the vertical axis. The worm and worm wheel above the gear case are for turning the whole of the latter round on its horizontal axis. By means of these two motions it is evident that the cutter bar can be turned in any required direction. The reciprocating motion above referred to is brought about by a worm upon the boss of the bar-driving pinion, which gears with two small worm wheels, each of which actuates a toggle by means of an eccentric pin. The toggles impart a to-and-fro movement of about 2 inches to the thrust block, and with it, of course, the cutter bar. A feather on the bar enables it to pass to and fro within the driving pinion. The combined rotary and reciprocating movement of the bar is said to produce a chipping and shearing action on the coal which greatly reduces the strain and effectually prevents the bar from clogging. The lower part of the gear case is filled with oil or grease. At the outer end of the bar bearing there is a stuffing-box to keep the oil in and the dust out. The motor, so the makers allege, is so inclosed as to be absolutely gas-tight, as well as to be protected from dust and external damage. The pole pieces with their coils are detachable from the sides of the shell. The armature is of the slotted core drum type, the core being built up on a cast iron hub, which also carries the commutator. The starting switch and resistance are inclosed in a case, which is also said to be gas-tight. The switch has a quick double break with renewable contacts. The haulage gear is worked automatically by means of a worm on the armature shaft, which operates a crank and ratchet. The rate of traveling may be quickly adjusted to adapt it to the hardness of the material met with. We understand that this may be done while the machine is at work by varying the throw of a crank. The hauling is effected by means of steel wire rope, and a self-coiling arrangement is fitted to the machine whereby the even coiling of the rope on its drum is insured. These cutting machines are made in three standard sizes. The power required to drive these is 12, 18 and 24 brake horse power respectively. The depth of undercut in the three cases is 2 feet 6 inches to 3 feet 6 inches, 3 feet to 4 feet 6 inches, and 4 feet to 6 feet respectively.

The makers claim a number of advantages of this type of coal cutter. The number of parts, they inform us, is fewer than in any other cutter. There are no bearings or rubbing surfaces under the coal where dust and dirt might subject them to excessive wear, an objection to which some of the machines in use are open. The cutters are capable of being securely fixed to the cutter bar and allow of simultaneous and easy inspection. The cut with this machine can be made either on the pavement or at the roof, or at any intermediate point, and the bar may be tilted to suit the rise or dip of the seam. Moreover, the angle at which the bar works may be altered at will while the apparatus is in operation, thus rendering it possible for the holing to be made in the best position. It is further claimed that it is almost impossible for the bar to be choked or jammed, and there is nearly entire absence of end thrust. The coal it produces is said to be rounder and the waste less than from any other machine, as the loose coal is not dragged out and broken up.

We have had an opportunity of inspecting this machine, and can bear testimony to the strength of its construction, but we have no personal experience of its working in mines, and we are, therefore, able to do no more than enumerate the makers' claims as set out above.—The Engineer.

HOW TO MAKE A DRY BATTERY.

By WILLIAM A. DEL MAR.

THE number of instructions to be found in various books on how to make a dry battery is legion, but they are so incomplete and indefinite, that the amateur finds it very difficult to produce a battery which will give as good results as those now on the market. The instructions here given will enable the amateur to make with ease any number of dry cells of the Burnley type. This is effected as follows:

Make one well-planed wooden block 5 x 3 x 2 inches, and one 5 x 2 x 1 inch. At one end of the smaller block screw in a hook as shown in Fig. 1. Now cut from a stout sheet of zinc a piece of 10½ x 6 inches and bend and hammer it round the block, as shown in Fig. 2, soldering the overlapping parts. When the side is soldered, cut along the four corners from the wooden block outwardly and hammer down and solder the projecting inch of zinc at the end of the block, as shown in Fig. 3. Now remove the wooden block and fill the zinc case with strong washing soda solution, which should be left in it for about an hour. Meanwhile, zinc cases for other cells may be prepared. Then remove the soda and rinse *thoroughly* with water.

Place in the bottom of the zinc cells about half an inch of the following mixture:

Plaster of Paris.....	85 per cent by weight.
Flour	15 per cent by weight

And on it place the small wooden block centrally with regard to the case and with the hood end up. Then make into a paste some of the above mixture with the following fluid:

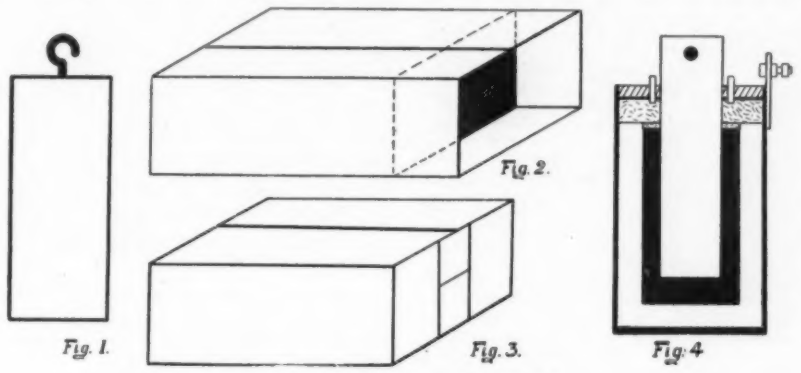
Concentrated solution of sal ammoniac	85 per cent.
Concentrated solution of zinc chloride	15 per cent.

Make about twenty cubic inches of thick, creamy paste and pour it into the zinc case around the wooden block to within three-quarters of an inch of the top. When the paste has set, pull out the block by means of its hook, and in the bottom of the hollow, put one-half inch of the following mixture:

Manganese peroxide...	60 per cent by weight
Powdered carbon	25 per cent by weight
Zinc chloride	5 per cent by weight
Sal ammoniac (powder)	10 per cent by weight

Then hold a carbon plate about 1¼ x 5 x ¼ inch (having a brass binding screw near the top), in the middle of the hollow but resting on the bottom, and pour around it a thick paste composed of the above mixture and water, to within one-eighth inch of the top of the outer mixture. Fill the zinc case to within one-quarter inch of the top with rasped cork and put in this a couple of glass tubes ½ inch long and of about ⅛ inch bore to project ⅛ inch above the top of the case. Cover all but the tubes with a layer of paper and pour molten sealing wax on this to the top of the case, leaving only the carbon and the two glass tubes projecting. A brass binding screw, soldered onto the zinc case completes the cell, which is shown in section in Fig. 4.

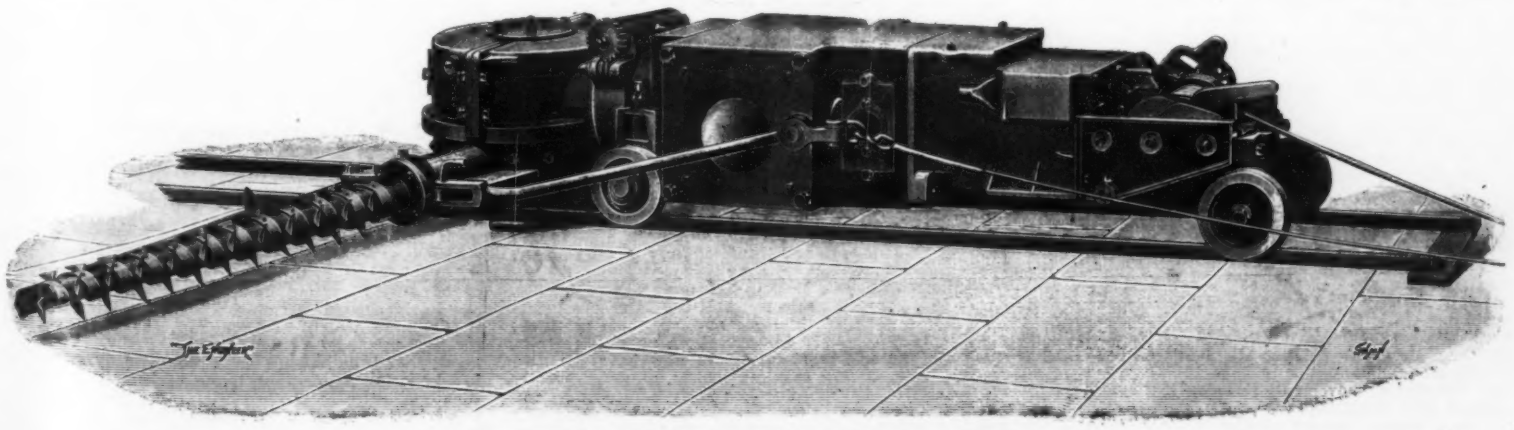
The cell should be inclosed and glued into a cardboard case, which will act as an insulator. This is especially required at the bottom where the battery touches the table. The cells, being thus insulated, and oblong in shape, may be packed together into batteries of any number, without loss of space. The electromotive force of such a cell is 1.45 volts.



DETAILS OF A DRY BATTERY.

ELECTRIC WAVES AND THEIR EFFECT ON THE HUMAN BRAIN.

IN an article by A. Frederick Collins, published in the London Electrical Review, some interesting experiments are described, which were conducted for the purpose of establishing the nature of the relationship existing between electrical storms and persons afflicted with certain forms of nervous diseases. The brain of a freshly-killed animal was procured, and an apparatus for sending out the electric waves of radiations was arranged. It was thought necessary to measure the resistance of the brain, and two needles connected to the testing set were embedded in opposite hemispheres. The high resistance offered by the tissues to the passage of an electric current, especially considering its large cross-section, was surprising. A telephone receiver was introduced in place of the testing set, and two resonator plates connected with two coherer plugs connecting the opposite sides of the brain with the resonator plates, and a dry battery and telephone receiver were bridged in between the two resonator plates. Waves were then sent out by the emitter at a distance of three meters, but there was no sound in the receiver. Had the waves appreciably cohered the brain cells, the telephone would have registered it. It then occurred to the author that the resistance of the brain, like loose metal filings, was too great, and its sensitiveness therefore proportionately decreased. The needles were inserted 1 mm. apart, and the key again pressed. There was a sharp click in the telephone receiver as though a carbon coherer had been employed instead of the brain cells. Time after time the experiment was repeated in all its possible variations, and with many other brains from mammals, but with the same results. The tests proved that cohesion of the brain cells in animals takes place after death under the action of the waves. In order to examine into the action of the living brain, a large feline was subjected to the process of etherization, and was soon in a deep hypnotic sleep. After an incision had been made and the plugs connected up to the opposite sections of the membrane, the needles of the receiving apparatus were inserted into the brain, and the telephone receiver was again selected because of its sensitiveness. When the sparks passed between the oscillator balls, the sounds of cohesion in the living brain were quite clear, though not as distinct as in the previous tests with the inert brains. The subject was subconscious of the effect, and more ether was applied. The clicking continued, showing that the brain cells were self-righting or "self-restoring," as it is called in the technique of wireless telegraphy. It was accidentally discovered that there were peculiar vibrations felt at the base of the brain and a rhythmic vibration of the muscles. When the emitter was stopped, the vibrations ceased; when in operation, the vibrations were



ELECTRICALLY-WORKED COAL-CUTTING MACHINE.

in evidence. The effect was similar to that produced with the so-called "shocking coil," only in this case the current was not broken by any mechanical means. These tests proved that cohesion of the brain cells of mammals in life takes place under the action of electric waves. The resistance of the cross-sections of the brain was measured and found to be about 5000 ohms, which, considering its dimensions, was high. In another test during a storm, a telephone receiver was used, and upon the lightning striking the cupola of a house a quarter of a mile away, three sounds, like the cooling of metal when immersed in water, led the author to believe the lightning had struck three times, which was afterward proved to be true. This was in conjunction with studying the effects of electric waves on the inert human brain, and seemed to the author to prove that cohesion of the brain cells in man after death takes place under the action of electric waves.

AUTOMOBILISM IN PRUSSIA.

I.—THE MOTOR-CARRIAGE EXPOSITION AT BERLIN.

THE Annual Pan-German Motor-Carriage Exposition was opened at Berlin on the 15th and closed on the 26th of May. As its title implies, this was not in any sense an international competition, like that of three years ago; but simply a friendly display by the Union of German Motor-Carriage Manufacturers, under the joint auspices of the German Automobile Club and the Middle European Motor-Wagon Association, which collectively includes most persons and firms in Germany who are interested in one way or another in the subject of automobiles.

Concisely stated, it has been a mechanical display, in which each manufacturer exhibited to his colleagues, patrons, and competitors the best that he has thus far accomplished, including, naturally, such improvements as have been made since the international exposition which was held here in September, 1899. The exhibition of this year has been somewhat inadequately housed in the premises of the Permanent Motor-Carriage Association—a series of low-arched showrooms under the elevated railway viaduct on Georgen Strasse. The location is central, but surrounded by narrow and crowded streets, and the rooms are so small that the open court, which is ordinarily used for showing motor carriages in motion, had to be roofed with canvas to provide sufficient space to receive the various exhibits. Nowhere during the recent competition has there been any space for testing, speeding, or showing any of the machines in action, except to take them out through crowded streets to the parks or suburbs, where they remained subject to the very strict police regulations which govern the use of motor carriages in all Prussian cities. For this among other reasons the exposition just closed, while highly interesting to automobile makers and other experts in construction, has been lacking in interest as a popular entertainment. So far as could be judged by the attendance the general public took but a languid interest in the display, and nine out of every ten persons to be met there were either owners of some kind of motor carriage or technically interested in their manufacture.

The list of exhibitors includes 105 firms, all German except two, one of which is a maker of springs and axles at Paris, and the other a manufacturer of small fixtures at Budapest. The United States was represented by one article—a polishing powder for metals—exhibited by the American Trading Company, of Berlin. All the great German manufacturers of motor carriages—Benz, Opal, Dürkopp, Daimler, Kühlstein, the factories at Eisenach, Leipzig, Nuremberg, and Marienfelde—were represented by their latest and best work and the display included about eighty vehicles of every type, from the ponderous 12-ton freight wagon or eight-seated "tonneau" to the motor bicycle, of which latter there was a large and interesting display from not less than seven different manufacturers.

It required but a glance through the rooms to show that the leading German builders have made great progress in automobile construction since 1899. Not only are the carriages in general lighter, more shapely and elegant in outward finish, but they conform more closely in model and relation of parts to modern standards of construction, as typified by the leading French machines. For reasons which will be hereinafter explained, steam carriages formed no part of the display. Electric automobiles were there, but so few in number and so unchanged from the types of three years ago as to form only a passive feature of the exposition, in which the gasoline and alcohol motors were supreme.

Of the sixty or more vehicles on exhibition, at least five-sixths were of the general type of the Mors and Panhard racing machines which are so well known in America—that is, with gasoline motors placed high in front, and transmitting the driving power either through chains or a longitudinal shaft and beveled gearing to the rear axle and wheels. Two makers—the Benz Motor Company, of Mannheim, and the Dietrich Company, of Niederbronn, in Alsace—still utilize their plan of power transmission from motor to driving wheels by means of a belt and pulleys. The one real novelty in this line is the device of Prof. Klingenberg, exhibited by the Motor Fabrik Pasig-Munich, in which the motor, inclosed in a dust-proof sheath, rests upon and is geared directly to the rear axle of the carriage. The axle is in two sections, connected at the center by a complicated device, and which provides for differential motion as between the two hind wheels and couplings for different rates of speed. The idea seems to have been adapted from a tricycle of French origin, and its application to a motor carriage is ingenious and interesting. The motor works directly on the driving shaft with the maximum economy of power; the working parts are not only securely inclosed and protected from mud and dust, but work in a bath of oil, which secures perfect lubrication. On the other hand it has the ominous disadvantage that the motor, with all the complicated and delicate mechanism of transmission and differential movement, rests on the axle without springs, and would therefore, in the opinion of critics, be soon shaken out of service by the vibration of travel over a rough road. For exclusively city use, over good pavements, this method of construction—which eliminates chains, cogs, and belts—might prove effective, but for open-country touring its durability is thought to be questionable.

The dominant note of this exposition has been the evidence everywhere made manifest of a general and notable improvement in many details, not only in the construction of motor carriages, but in the many fixtures connected with their use for pleasure, sporting, or business purposes. Three years ago few of the carriages exhibited were provided with ball bearings; now they are universal and of unsurpassed quality. The puffing, noise, and vibration formerly so disagreeably incident to all hydrocarbon motors, although not yet overcome, have been greatly reduced by the inventions of the past three years. The same improvement is noticeable in pneumatic tires, in the greater lightness and beauty of wheel construction, in which slender metallic hubs with ball bearings, light but strong wooden spokes, and improved methods of fastening and removing tire mantles, have been utilized.

The whole subject of electrical igniters for gas and spirit motors has made great progress in Germany during recent years, and the exhibition included several kinds which furnish an effective and reliable spark with a minimum consumption of current. Some of these are fed from storage batteries; in other cases the current is generated by a primary battery or a small dynamo carried in the automobile and driven from the axle. Among many improved fixtures were a set of reservoirs in which benzine can be kept with the greatest measure of safety, and a motor carriage tank filled by a device which registers automatically the amount of fluid taken and indicates by a dial at any moment the quantity remaining in the tank. This system is a check upon the tendency of some chauffeurs to overcharge their employers for gasoline consumed.

II.—THE PROGRESS OF AUTOMOBILISM IN BERLIN.

It has been stated at the beginning of this report that the attendance at the recent exposition was mainly confined to persons technically interested in automobile manufacture, and that the general public took but a languid and incidental interest in the display. This was the result of several causes—the restricted quarters in which the show was held, the absence of races or other open-air tests or exhibitions of machines, and, finally, because automobilism as a means of locomotion, sport, or recreation is still in the development stage in Germany. Notwithstanding all the energy, ingenuity, and enterprise of various German builders, their sales have been in many cases slow and discouraging, and the number of motor carriages in actual use for travel and sporting purposes is relatively small. The Deutscher Automobil Verband, which lent its aid to the recent exposition, comprises the sixteen clubs, which have an aggregate membership of about 900 persons and collectively include the automobile public of Germany. These clubs are located at Berlin, Dresden, Frankfort, Halle, Munich, Hanover, Cologne, Leipzig, Strasburg, Bielefeld, Freiburg, Nuremberg, Hamburg, Breslau, Stuttgart, Düsseldorf, and Schoeneberg. They are in general well organized and efficiently managed; but there has been thus far in Germany no such popular interest in automobilism as has been seen in France, England, and the United States. This is apparently the result of a combination of causes, among which may be cited the very strict and rigidly enforced police regulations to which all motor carriages are subject throughout Germany, and the fact that during the past two years the independent and leisure classes of people have suffered losses through the depression of business and depreciation of industrial and other securities, and have been therefore slow to invest in a luxury so costly and complicated as an automobile. There has never been—probably never will be in Germany—any such surrender of the public streets, parks, and country roads to motor carriages as has been seen in France, or even in Italy and Austria. Throughout Prussia, the rate of speed permitted within municipal limits is limited to 12 kilometers (7.45 miles) an hour, and if this rate is exceeded there is inevitably a policeman in sight to halt the offender and bring him to justice. The result of the Paris-Berlin race of last year was to deepen and confirm the conviction of German municipalities that the automobile is an intruder to be handled with firmness and discretion.

Finally, the average German is a discreet, conservative, intelligent purchaser, who considers carefully and well before investing in any new thing which he does not fully understand. In respect to automobiles, he knows that while the German builders have made during the past few years great progress in respect to certain details of construction, while the motor carriages now turned out are distinctly superior and even cheaper than those hitherto offered, there is as yet no definite agreement between makers or users as to what an automobile should be. The vehicle is still in the development stage, and has yet to be standardized, even in its most essential parts. The motor carriage has yet to be so perfected in construction that, like the bicycle, its parts can be made interchangeable without special fitting by an expert workman. As a consequence, each vehicle is still an original and individual construction, and its cost unduly great. Three years ago it was thought that the electric carriage—or perhaps a combination of gasoline and electric motors that could be made self-sustaining and independent—would be the machine of the future. Now, the electric vehicle has been practically abandoned because it requires an expert electrician to manage it, and is, moreover, generally heavy, costly and limited in working radius to the neighborhood of towns with electric lighting or power plants. It is therefore set aside to await the further development of the storage battery; and, as steam carriages are not yet permitted to be used on public streets in Prussia, the hydrocarbon motors now have the field to themselves. The gasoline vehicle, although greatly improved, is still more or less noisy, malodorous, and subject to vibrations that constrain the intending purchaser to wait still longer before choosing a machine.

III.—STEAM CARRIAGES IN PRUSSIA.

Under such general conditions, it was naturally thought that American steam carriages of the run-about type, which are cheap, easily managed, and run without smell, noise, or unpleasant vibration, would find a ready and appreciative market in Germany. One of these machines built by the Locomobile Company of America was brought to Berlin in the winter of 1901 and attracted much favorable attention. But when the new code of automobile regulations went into effect in April, 1901, a special license became necessary, and it was found that the American locomobile collided at eight points with the Prussian law governing the construction and use of steam boilers. This elaborate and comprehensive statute was enacted on March 9, 1900, before the motor carriage had become a factor in transportation. It comprises forty-five sections, which prescribe with minute and elaborate precision every detail in the construction and use of steam boilers. Having been made for stationary and locomotive engines, these specifications naturally could not be adapted, unchanged, to automobiles; and, as a consequence, the steam carriage, although licensed in Austria, Saxony, and Bavaria, has been thus far practically excluded from Prussia. During the past six months, however, a movement has been organized and carried through by which the statute has been amended so as to permit the use of steam carriages which fulfill in their construction certain conditions. Under these revised conditions, the locomobile of America has been granted a concession—not yet officially issued—to be sold and used throughout Germany upon condition that three trifling modifications shall be made in its construction. One of these requires that a certain tube shall be 15 instead of 10 millimeters in caliber; the second relates to the outer shell of the boiler; and the third requires the water-gage cocks to be pierced in front so that any stoppage from dirt or boiler scale can be detected and removed. With these slight and inexpensive changes, the locomobile will be admitted to what is practically a virgin field for steam vehicles, and when converted—as it easily can be by a slight change in its gasoline burner, so as to adapt it to alcohol as a fuel—its success would seem practically assured. The whole influence of the German government is directed toward the substitution of crude alcohol for petroleum products wherever possible, and makers of motor carriages and other machinery for this country should take that fact into account.—Frank H. Mason, U. S. Consul-General at Berlin.

HISTORY OF THE INVENTION OF INCANDESCENT GAS-LIGHTING.

By AUER VON WELSBACH.

IN the year 1880 I was occupied with the chemistry of the rare earths. The remarkable phenomena exhibited by some of these earths, when heated to a high temperature by a flame, excited my interest to a great extent. One body in particular, called erbia by chemists, behaved in an altogether singular manner. It did not become luminous like other bodies and give off white or yellow light, but its radiations were green. Science has not yet been able to give any explanation of this remarkable phenomenon. This fact, which was interesting and astonishing to the highest degree, may be compared with the observations recently made on the radiations from polonium, for example.

I refer to this phenomenon because it interested me very greatly, and was, so to speak, the starting-point of my discovery. The spectrum given by this earth is not continuous; it is a band spectrum such as is given by but few solid bodies.

The examination of the light emitted by the rare earths raised to incandescence was very important in the study of these compounds. But the little beads easily obtained on platinum wires are not suitable for the production of very luminous spectra. I therefore arranged the earths in the flame in such a manner that the emission of light should be much more intense. It occurred to me, quite by chance, to soak cotton with the solutions of the salts of these earths, and then to calcine them. It seemed probable that this experiment might not succeed, and that the skeleton formed by the earths, after the combustion of the cotton, would not have sufficient coherence. However, it was a success; the earths retained the shape of the cotton. Shortly afterward, when I visited my old master, Bunsen, at Heidelberg, and explained to him how I had manipulated these compounds, he shook his head and said that it seemed impossible to him that a coherent mass of oxide could be obtained in that manner. I still remember with pleasure the astonishment he evinced when I was able to show him how I obtained my mantles.

During the course of my experiments to give these earths a structure appropriate for their luminous emissions, I came across one substance of which the very considerable emissive power was then but little known, for the reason, as I have stated, that these bodies had only been examined in the form of small beads. This compound was oxide of lanthanum, and it is this substance that gave me the idea of utilizing the rare earths for the production of light on the large scale.

The mantle of oxide of lanthanum seemed perfect, but in it I found my first disappointment. I was away from the laboratory for several days, but had left the mantle carefully locked up; when I returned it was reduced to powder. I repeated the experiment with the same result. Oxide of lanthanum was always reduced to fine powder. My first joy was of short duration.

Then I began to think whether I could make oxide of lanthanum, whose emissive properties I was so absolutely certain of, more stable by mixing it with a compound which would attract the moisture and the carbonic acid of the air less easily. I experimented first on magnesia. I was already aware of the importance of the extreme division and the intimate mixture of the material to be calcined. The pulverization ought to be integral, and I named these mixtures molecular mixtures. When we mix these

bodies in this manner and calcine them their properties undergo important modifications. White magnesia and white oxide of lanthanum, on being calcined, give a substance of a deep brown color, and the properties of the compounds can be no longer recognized in the product. The first satisfactory compound for incandescent lighting with gas was formed of the oxides of lanthanum and magnesium. It did not fall to powder in the air after calcination, and it gave a beautiful light; however, its useful effect was not yet very great, it was just about that of a Siemens regenerating burner. But it had one great fault: after seventy or eighty hours of heating it became translucent and vitreous, losing its porosity. Thus, finally, this second attempt did not succeed.

I studied this question anew, from the chemical point of view; it was evident that magnesia did not resist fire sufficiently, that it could not undergo a prolonged calcination without being considerably modified. So I turned my attention to mixtures having oxide of zirconium as a basis. The results obtained were better. This mixture gave a steady light, and its life in the flame reached some hundreds of hours; this success gave me further encouragement, and at the same time I made experiments with oxide of thorium, and was surprised at the intense increase in luminosity of the mixtures containing this substance. These experiments showed that certain molecular mixtures of oxides constituted alloys, so to speak, which emitted a particularly intense and constant light when placed around a flame in the form of a fine net-work.

I already looked upon it as a certain fact that a new system of lighting could be founded on these phenomena, more economical and advantageous than the use of gas in the form of ordinary light-giving flames.

It must, however, be remembered—and this is the key to the invention of gas-lighting by incandescence—that the question was not to find a process by which an infusible compound could be given a definite shape. This invention is founded, above all, on the fact, proved by numerous experiments, that molecular mixtures of certain oxides are possessed of properties which cannot be deduced from those of their constituents.

Encouraged by all these results, and sustained by my experiments, I was bold enough to look upon the efforts made for the previous ten years to augment the lighting power of the gas-flame as useless. It is, in fact, evident that, the emissive power of these compounds being double or treble that of the simple flame with an equal consumption of gas, it is more economical to give up the use of a luminous flame. It is far better to use a non-luminous very hot flame to raise these new bodies to incandescence.

I now come to some well-known facts. I gave a small demonstration to the Viennese press in the laboratory of M. Lieben, and the reports, which were for the most part favorable, announced my invention to the public. While some looked upon this invention with approval, others affected a good deal of skepticism, or made fun of it. I am acquainted with a well-known gas engineer who was always ready to bet with anyone he met, that less than 1000 burners a year would be installed in any town. Another one, when asked to interest himself in the new invention, said: "In my works we only take notice of serious ideas."

These answers did not affect my confidence. Incandescence by gas was welcomed, and gradually gave rise to a certain amount of business. I was obliged to leave this subject for some time, my attention being occupied by contracts and other matters. For the purpose of continuing this work I found a very distinguished man who rapidly set about the manufacture of the "lighting fluid," as we named it. This was M. L. Haitinger, whose work on this subject must not be forgotten, and to whom I owe most hearty thanks.

He soon made the interesting observation that the compounds of cerium, which were present in small quantities in the material, were of great importance with regard to the emissive power, and that under certain conditions it was very advantageous to increase the proportion of cerium. He submitted all the mixtures to very exact analysis, and could thus make sure of a good preparation. Eventually I returned to this work and made some hundreds of experiments, without great success, to increase the luminosity of the mixtures. The industry of incandescent gas-lighting was in difficulties, and a continuous sort of stagnation set in; those who had doubted in the beginning again raised their voices, and a very painful time passed for me. Capitalists, mistaken in their hopes, became impatient, and instead of giving me time and leaving me to work quietly, threatened me with legal proceedings. The factory constructed some years before at Atzgersdorf was closed down, and its staff of chemists departed to the four quarters of the globe; finally, I took possession of it and remained there alone.

"Necessity is the mother of invention." It was necessary to achieve something. I started fresh experiments on all possible bodies, but in vain; incandescence by gas did not appear to be susceptible of improvement.

At the commencement of my experiments I had, as I have said, directed my attention to oxide of thorium, and I had observed that it excited the emissive power of other earths. The light given by mixtures having a thorium base was intense, but it did not last. It decreased after about fifty or sixty hours, and was no better then than that from mantles not containing thorium. This astonishing fact made me think that thorium had not yet been examined with sufficient care from the scientific point of view; that is to say, that it contained some substance hitherto unknown to chemists. There chanced to be in the stores at the Atzgersdorf factory a certain quantity of raw, impure thorina. I set myself to work examining this substance, which was then very rare and expensive. I soon found several chemical methods for treating this compound in a much more simple fashion than it had been done before; among others those methods of crystallization which enabled me rapidly to prepare the pure salts of thorium. A curious fact was then observed, the purer the thorium the less intense was the light given by the mantle made from it. I followed up these experiments, and finally obtained a mantle which only gave a light of two candle power, and I convinced myself by a careful analysis that the thorium which composed it was purer than any of my other preparations. From this I concluded, perhaps a little hastily, that thorium was not an element, but that it could be decomposed. The examination of the mother-liquors showed that they contained the real luminous substance. The decomposition thus seemed to be apparent, but in the mother-liquors from the purest portions I could not find any foreign body. Subsequent experiments, however, enabled me to prove the existence of this luminous compound.

This body, closely allied from many points of view with thorium, and of which the salts were entangled by the salts of thorium, although they were not isomorphous—this body was cerium. The synthesis of the mother-liquors was a simple task; I gradually mixed a solution of cerium with a solution of pure thorium, and I obtained the astonishing light that everyone now knows. The emissive power of the new mixture was about three times that of the old; its life was also much longer, and it opened a new era for incandescent lighting by gas. I made this experiment with the greatest care; I measured the resistance to the action of the air and of the flame, and the decrease in the illuminating power, and at the beginning of the year 1890 I again brought incandescent gas-lighting before the public.

As a general rule the mantles have been kept to this last composition; that is to say, 99 per cent of oxide of thorium and 1 per cent of oxide of cerium.

The value of my patents had then fallen to a minimum, and it was high time that these new results were achieved if I did not want to lose the last few faithful friends who remained to me. Among these I may mention the firm of Julius Pintsch, of Berlin, who were also the first to replace the woven by the knitted mantles, an important improvement I had forgotten to mention.

From the development of incandescent gas-lighting, as I have just described it, it can be seen that my work was not based upon that of others.

When incandescent gas-lighting had arrived at this point the era of lawsuits commenced. Numerous persons, after having rummaged old volumes to find something analogous, came and told me a number of things and names I had never heard mentioned before. I maintain that incandescent gas-lighting was born at Vienna, and that neither I nor my collaborators have ever used the inventions of other people, and I think I have given the best proof of this by what I have said above.

As for this singular property which is possessed by this mixture of 99 per cent of oxide of thorium and 1 per cent of oxide of cerium, it can be seen, it can be observed, but it cannot be explained. This powerful emissive property cannot be foreseen from any property of thorium; this latter hardly possesses it. We can give no exact scientific reason for this excitation of emissive power by cerium, and I expect we shall have to wait a long time before it is explained.

I myself can give no explanation, but I can point out certain analogous facts. These are only ideas, and are not absolutely based on experiments, but still I should like to refer to them briefly.

A body having this emissive power, that is to say, susceptible of emitting an intense light when raised to incandescence in a flame, is composed of infusible oxides in molecular mixture. The principal constituent of this mixture should remain intact in the flame, while the other may be easily reduced and oxidized.

The ponderable relationship between the elements in the mixture should depend on the pressure at which we operate; at the atmospheric pressure this relation is 1 of cerium to 99 of thorium; it might be much more at a pressure of 100 atmospheres.

The gas of the flame successively and very rapidly oxidizes and reduces the emissive substance at the points where it is situated in the mantle. If the constituents of the mixture could form a compound when one of them is in a state of higher or lower oxidation, the compound would be quickly destroyed at the moment when the body concerned passes from the usual to the other degree of oxidation. The earths are in a state of extremely fine division, and are surrounded by a mantle of flame both oxidizing and reducing. If reduction takes place there is also decomposition, and if oxidation there is recombination of these elements; these reactions may go on several million times a second, and molecular shocks are produced which give rise to luminous oscillations of the ether, and the body becomes incandescent.

We may make use of all the substances formed according to this general principle, and for a low consumption of gas they give an intense light. When we examine the whole series of these bodies, of which M. Haitinger has found some, we find another peculiarity which the oxides in the form of salts give to emissive mixtures. These bodies are not chemically but physically analogous; in a certain sense they are isomorphous; that is to say, they crystallize together and form special double salts; the double salts of cerium and thorium are an example. Among the bodies having this emissive power when calcined in molecular mixture we may mention alumina and oxide of chromium. These bodies behave like the oxides of thorium and cerium, only their emissive power is very much less. Oxide of chromium plays the part of the easily oxidizable and reducible oxide, and the alumina that of the infusible basis.

Oxide of chromium and alumina, chromium and aluminium, are not very closely allied from the chemical point of view, still they combine, and each form a series of isomorphous double salts, the alums. Another example is the excitation of this emissive power in lime and strontia by uranium, another discovery of M. Haitinger's.

Small quantities of uranium have the same effect on oxide of thorium. With lime the emissive power of this mixture is very considerable, and for some time we thought of applying it commercially. There again we see the same relations appear. The lime is the infusible basis and the oxide of uranium is the easily reduced and oxidized body. Although these two elements are not closely allied chemically they from certain compounds, of which uranocalcite, which is found in nature, is an example. Their oxides, like their salts, can combine and separate according to the degree of oxidation of the oxide in question. I do not know whether my hypothesis will be acceptable. I have given it because many facts are in its favor, and I know of no observations which are opposed to it. Possibly, again, this explanation might help the development of incandescent gas-lighting.—Journ. fur Gesbeleucht. und Wasservers.

MEDICAL LITERATURE.*

A CRITIC once ventured the opinion that the readers of most literary productions drew the line, variously placed, between being properly edified on the one hand and being becomingly bored on the other. Further than this he was free to say that very many of the books and articles were scarcely read at all save by those whose duty it was to tell how worthless they were. The main ends of the hopeful authors were thus rendered entirely purposeless. This outcome of laudable effort was not due so much to lack of knowledge of the subject as to the style and method of its preparation.

All this applies so directly to the medical literature of to-day that it can serve as the excuse for some general considerations bearing upon the proper means to a given end. The medical man, as a rule, should, by virtue of his cultivated powers of observation, be a good writer. He is trained to observe and interpret facts, and he should have an equal power in expressing them. That this is the exception in a very general sense rather than the rule, is painfully evident in the dull and wordy pages of our many medical treatises and in the long, stupid and tiresome articles that so often fill the columns of our medical periodicals.

When a great painter was asked by a pupil how he mixed his colors, the significant reply was, "With brains, sir." Another artist solicited to criticise a picture, after commenting on the conception, the coloring, and perspective, offset all his praise for the work in general by emphatically declaring, with an appropriate gesture, that it lacked snap.

Both judges had the proper appreciation of the real art of putting things—the proper reciprocation of giving and taking. It was not the mere formulation of an idea, but its practical application to the actual receptivity of the one for whom it was intended. No one needs be told that the hole in the bull's eye has any other reason for its existence than due accuracy in aim. This question of hit or miss should concern every writer who wishes to make the proper score with his readers. It is the instinct of precision and directness in the start and its proper cultivation afterward. It is the saying of the thing to be said and knowing when to stop.

Fulsome writers rarely, if ever, escape being tedious—and their number is legion. They inflict themselves upon us at every opportunity, and write against time and space; so that the mere title of the article is of itself enough to forbid further reading. What should be in one volume is amplified into a series, and one page of facts is diluted into ten of senseless and inapplicable theories. The difference in interest of many medical articles is strikingly manifest from this point of view. A practised writer handles his pen as an artist does his brush. The subject is balanced properly from all sides and the fine touches bring in the high lights with their proper telling effects. It is the presentation of the salient facts as they appear to the practised observer—what interests him interests his reader.

Scientific writing, dealing as it does with facts, should be necessarily terse in style, but this is no argument against decent literary finish making easy and interesting reading. The medical man who is skilled in descriptive writing has a better opportunity for exercising his talent than most authors in any other line of work. In fact, his field has been so constantly trenched upon by makers of fiction that there is no excuse on the score of lack of material for most finished literary effort. What may be imagined by the novelist is real with him. He has simply to describe what he sees day after day in hovel or palace, and the actual drama of human suffering shows itself in all its forcible and realistic outline. The more accurately the clinical phenomena are presented, the more useful and interesting they become. What finer medical classic, with its easy narrative style, its accurate pictures of diseased conditions, its charming rhetorical allusions, and its graceful rendering of classic English, can be found than "Watson's Practice of Medicine," which was to medicine what Blackstone was to law? But where are their equals to-day? The ancient writers were models of their kind in accurate delineation of clinical phenomena, and their facts stand for all time. We know their statements were truthful, because we verify them every day centuries after they were written. Theories have come and gone, but, with ever-changing views as to the reasons for this or that symptom, we rehearse the incontrovertible fact every time we feel a throbbing pulse, listen to hurried pant, note a sluggish pupil or watch for the face of death. The picture is always before us, but the hand of the present-day delineator is fast losing its cunning. We are drifting into machine-like methods and working in ruts. Our books are arranged on stereotyped plans, and individuality is lost in efforts to cast our figures in conventional molds. It is bulk against compactness. Aspiring medical journals pride themselves on the number of pages they can print and the quantity of paper that can be wasted. The much gives way for the what—the form for the substance. Any one accustomed to read manuscript for publication and to wade through books for review, knows how few good writers there are, but the touch of the master hand is seen as readily in the first paragraph as in the last sentence. When the latter is manifest the reader takes a second look and contentedly and profitably goes on to the end. If the writer is seeking a large and appreciative audience his first thoughts should be brevity, terseness and point em-

* Medical Record.

phasizing his best efforts in the direction of the parallel cardinal virtues—faith, hope and charity—the last the greatest for the expectant reader.

SISAL HEMP CULTURE IN YUCATAN.

By CHARLES RICHARDS DODGE.

AMONG the hard fibers, so called, the henequen or Sisal hemp of Yucatan must take first place as a fiber product of the American continent, standing only second, in my estimation, to the Manila hemp of commerce, produced in the Philippine Islands. During a recent visit to Yucatan the writer was enabled to study the growth of the Sisal hemp product, *Agave rigida*, under most favorable conditions, and to learn some new points in relation to the commercial side of the fiber production, which are worthy of record. Reference is made in this connection to the treatise on *Agave rigida* (varieties) in the Descriptive Catalogue of the Fiber Plants of the World, published by the Department of Agriculture.

FIG. 1.—FLORIDA SISAL HEMP PLANT OVER SEVEN YEARS OLD.

At least 70,000 tons of Sisal hemp finds a market annually in the United States for the manufacture of cordage, these figures not including cordage and other manufactures from Sisal also imported. About eight years ago the price of the fiber was three and a half to four cents per pound, while now the best grades bring ten cents, the American and European demand for the fiber being so large that the hemp farms around Merida have become veritable "gold mines."

The preparation of the fiber for market is a simple proposition, though the establishment of a new plantation is a question of years. The stiff, sword-like leaves of the plant are a mass of epidermis and pulp, in which the straight, creamy yellow fibers are embedded, these serving as the "bones" of the leaf structure. The lower and older leaves are cut close to the head, tied in bundles, piled upon little flatcars and run to the factory over diminutive narrow-gage railroads which extend to every part of the farm. At the factory the bundles are sent up to the machine platforms by endless carriers and dropped upon the feed tables. The leaves are then fed, one by one, by a Maya Indian attendant, into the grip chains of the machine, these endless chains conveying them to the scraper wheels, where the fiber is extracted and cleaned automatically in an instant, the same chains carrying the cleaned fiber to other attendants—usually boys—who secure it and lay it evenly in piles. A dump car under the machine platform catches all the waste, and as these cars are filled they are run out over the same railroad to the dump pile. The wet fiber then goes to the yard to be dried in the sun, spread over low frames upon which galvanized iron wires have been stretched. When thoroughly dry the fiber has only to be sorted and baled and it is ready for market. The seat of the industry is Merida, Progreso being the shipping port, whence the fiber goes to many portions of the world.

A glance at Fig. 1 shows the Sisal hemp plant as it grows in a semi-wild state in southern Florida. Fig. 2 shows the cultivated plant in Yucatan when it is (nominally) "five years old," this being the age at which the leaves are first cut for fiber. It should be explained, however, that the ages of the plants in cultivation are calculated from the time when the root suckers are set out to form a new plantation, at which time these suckers may have been growing three years or more, uncared for, before transplanting. So a field of five-year-old plants may, in reality, be eight or nine years old, at which stage of growth from the baby plant the leaves are considered fit to be taken for fiber.

From the age of five years and upward—from the date of transplanting—to the time when the plant blossoms, and dies, twelve to fifteen leaves may be taken off annually for the extraction of fiber. These leaves are about four and a half feet long, four to five inches wide and a quarter of an inch in thickness, and weigh from less than one pound to over two pounds each. In Yucatan the conditions of soil and climate are such that a plant may live to be twenty, twenty-five or even thirty years old before blossoming; while some, it would appear, never blossom, as very old fields were seen by the writer where the plants were simply drying up and dying of old age. Fig. 3 shows the appearance of old plants in Yucatan, those photographed being fifteen years old from transplanting.

In southern Florida, where the Sisal hemp plant was introduced as an experiment nearly seventy years ago, I have never seen a plant with a definite trunk as in Fig. 3, the blossoming always occurring when the plants are under ten years old (from the first inception, for they are not cultivated in Florida, and therefore are not transplanted). The flowering of the plant, as I have stated, ends its life.

In the question of the longevity of the plant is involved a dollars' and cents' proposition. If the leaves of a plant, as they develop, can be annually cut until it reaches an age of twenty years in cultivation before blossoming, as in Yucatan, it means that an annual crop of leaves may be taken for fiber during a period of fifteen years. Look again at Fig. 3, a fifteen-year-old plant in Yucatan. Unlike Fig. 1, it has not only developed a definite "trunk," but successive annual cuttings of leaves has added to the length of the trunk, so that the leaves, instead of spreading out near the surface of the ground, are produced at the height of a man's head. Nowhere out of Yucatan has the writer seen a Sisal hemp plant with a trunk like Fig. 3, nor a photograph of such a plant, with one exception—the exception proving the rule. A photograph of two lone plants in eastern Mexico has been shown me, where there was something of a trunk, doubtless the result of some peculiar local conditions. Many mature plants were examined by the writer in Mexico proper, growing in mere experimental plots in good soil. Where the plants were observed to be blossoming freely, and the matter was looked into, it was learned that they had not been set out longer than seven or eight years. And many in these plots had already blossomed and were dead.

Recent photographs of the Sisal fields of the Bahamas tell the same story, and it is scarcely ten years since the industry was started in those islands as a commercial venture. Fig. 4 is a group of Bahamian Sisal plants, already blossoming, from a recent negative by Mr. L. H. Dewey, of the Department of Agriculture.

If the peculiar conditions which prevail in Yucatan produce plants that will survive twenty and twenty-five years, while in other countries they will blossom and die under the age of ten years, it is obvious that the Yucatecans have a decided advantage in the matter of extended usefulness of the plantations after they have reached maturity.

Regarding the influences which retard the blossoming in Yucatan, there should be an investigation before conclusive statements are made. The farm owners in Yucatan tell me that cutting the leaves for fiber retards blossoming, say, for three or four years. My own idea, based upon observation during a limited visit, is that the soil around Merida, being largely no soil at all, but honeycombed ledges of coral rock—in the crevices of which the plants are often propped in place by small stones until they root—the plants mature so slowly that there is no excess of strength or vitality to be employed in building up a fleshy leaf, or rank growth of pulp cells, at the expense of fiber, for it has been shown again and again that a thick succulent leaf yields but little more fiber than a thin hard leaf produced under more arid conditions. Nearness to sea level, with high temperature, if not the influence of the sea air itself, has much to do with the favorable conditions of growth which prevail in Yucatan. It is agreed by the owners that too much water is infinitely worse than too little water. In point of fact, the Yucatan plants get no water out of the rainy season, and yet everywhere that the writer went, almost at the end of the dry season, the plants were found in apparently superb condition. The fields were so dry in places that smoking in them was not tolerated for fear of destruction by fire.

Transplanted into good soil rather than setting out in coral rock, the plants are able to utilize the water in the soil for a long time after the rainy season is over, the leaves becoming larger and more succulent and tender and maturing earlier. A leaf from an experimental plot in eastern Mexico, weighing thirty-four ounces, and grown in good soil, yielded 41.02 grammes of fiber, or about 1 2-5 ounces, while a 25-ounce leaf from Yucatan, of about the same age, yielded 41.65 grammes. Another Yucatan leaf grown in a very stony field and weighing only 14 ounces produced 31.47 grammes of fiber.

The facts are interesting, and those who may be contemplating the culture of Sisal hemp in other lands can well afford to investigate the subject from the standpoint of their personal interests and as a money proposition, for it will make some difference with the profits of a venture whether the life of the plantation, after coming to maturity, is to be twenty years or only three or four years.

FIG. 2.—FIVE-YEAR-OLD YUCATAN PLANTS.

FIG. 3.—OLD YUCATAN SISAL HEMP PLANTS.

PROBLEMS IN THE CHEMISTRY AND TOXICOLOGY OF PLANT SUBSTANCES.*

THE organic chemistry of to-day is the chemistry of the approximately 50,000 carbon compounds, enumerated in the recent edition of Beilstein's "Handbuch der Organischen Chemie." Most of these compounds are the fruit of research in purely synthetic chemistry, enormously stimulated, as it has been of late, by the growth of new, far-reaching conceptions in physical chemistry, and, especially, by the substantial rewards of the chemical industries which have arisen as a result of these investigations; a considerable number of the compounds enumerated have, however, been isolated from plants. Some of this work of plant investigation has been adequately rewarded, but as a rule it has only awakened a greater esteem for the investigator. The larger returns of synthetic chemistry are still enticing most of our best organic chemists into its fold, but its phenomenal success in producing substances such as urea, sugar and several plant alkaloids and glucosides hitherto known only as the products or educts of life, has stimulated inquiry not only into the chemical nature of cell life, but also into the chemistry of the dead principles that may be isolated from these cells. Mother Nature is, however, a very cunning and crafty chemist, with a keen understanding of all the requirements of cell growth under astonishingly varied conditions of environment; and especially with an eye for the protection and perpetuation of her multitudinous progeny against the ravages of parasites, or of man and beast, she has built up a very great variety of compounds, the properties and methods of formation of many of which she still holds secret. Many of these compounds, especially those primarily designed for the protection of the plant, react physiologically on diverse forms of animal life, and are, therefore, recognized by the medical fraternity and by chemists as "active principles." All which produce disturbances of the normal functions of an animal when introduced into its economy are, according to Hermann's well-known text-book on pharmacology, called poisons.

It is a sad commentary on the present state of our knowledge of plant chemistry that all we know chemically about the active principles of many plants is that the plants themselves are poisonous. Chemistry might be excused for her lack of interest in examining such physiologically-inert bodies as cellulose and chlorophyl, but it would seem that the plant poisons should at once challenge attention simply on account of their great tendency to react chemically, as they do with some one or more of the essential constituents of the animal organism. The dreaded effects upon man of such plants as the "deadly upas," the "deadly manchineel," or the common "poison ivy," deter many chemists from handling them, and, as shown above, there is little inducement financially for one to enter into such investigations, but the chemist's lack of a knowledge of botany is more frequently the controlling factor in this neglect. Many of the most interesting problems of plant poisoning cannot be conceived either by the chemist or by the botanist alone, but one who is constantly looking at these problems from both points of view could not well be thrown into intimate touch with the subject long before many interesting problems would be presented to him for solution. When once conceived these problems are readily susceptible of treatment, either by the chemist or the physiologist alone, or by one or both of them in conjunction with the botanist, the biologist or the pharmacologist. It was with the object of interesting you, as chemists, in this line of work that I was induced to select it as the subject of my discourse on this occasion. No more interesting and self-sufficient life-work could possibly be suggested to a young student starting on his college career than the investigation of plant poisons. As fascinating as a game of chess, the work calls forth, for its most successful treatment, the widest activities of mind and the most skillful handling of finely adjusted instruments. Art and literature lend a peculiar charm to the work, while the warm plaudits of men await him who solves any of the important chemical problems of immunity. This inviting field comes, I maintain, as properly within the scope of plant chemistry as within that of medicine, for disease is simply a disturbance of the natural functions of the animal economy, caused by poisons, many of which are excreted within the affected animal by such low plant organisms as bacteria and perhaps molds. Indeed it has been shown that all of the lesions supposed to be caused by certain living bacteria can be produced by the administration of sterilized filtrates obtained by passing extracts made from the bacteria through a Pasteur filter.

Plant poisons divide themselves most naturally and most comprehensively according to their plant origin; all attempts at a chemical classification have been incomplete because of our ignorance of the composition and structure of many of the compounds, while the physiological classification is unsatisfactory on account of our ignorance of the chemical composition of the compounds and of their exact mode of action on animal life. Let us inquire into the nature of the parallelism which exists in the grouping of plant poisons, and the grouping of the plants which contain them!

Plants are commonly divided into species, genera and families, and these are grouped into two series—the flowering and the non-flowering plants—the latter being the more simple morphologically. Each of these in turn is grouped into smaller classes. Proceeding from the more simple to the more complex, we have in the non-flowering plants such groups as the bacteria, the diatoms, the molds, the fleshy fungi, the mosses and the ferns, while in the flowering plants we have the monocotyledons with parallel-veined leaves and the dicotyledons with net-veined leaves. This classification is in general based on the general morphology of the plant, but in the lower orders, especially in the bacteria, the chemical composition or at least the chemical and physiological reactions which the plant is able to induce are taken into consideration in the differentiation of the species. In many of the subdivisions in the higher groups, however, there is often an apparent chemical basis for classification. It seems just as reasonable to suppose, as van Rijn has shown in his book entitled "Die Glykoside," that there should be genetic relationships between chemical substances represented in any one group of plants, as that there should be morphological relationships. Both results are brought about entirely by the energy of the living cell, a process which is undoubtedly largely chemical in its character, and would seem almost as necessary for a plant to gradually evolve new and therefore closely related chemicals for slight changes in environment, as that it should evolve new and closely related forms for the same purpose. The relationship between the chemical

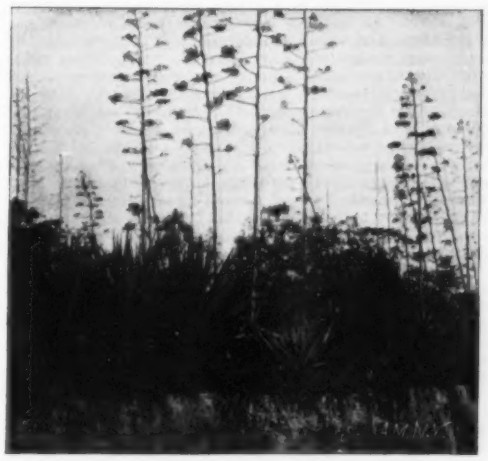


FIG. 4.—BLOSSOMING BAHAMA SISAL HEMP PLANTS.

constituents of certain groups of plants cannot, of course, be so apparent as is the morphological relationship, simply because it cannot be determined by inspection alone, as the latter can. If, therefore, our knowledge of plant constituents were sufficiently complete we could perhaps write monographs classifying the different species of plants according to their chemical constituents as well as we now write monographs based solely on morphology. The same alkaloid is often found exclusively in certain families of plants, but the same family, and even the same species, often contains one or more alkaloids which differ from each other by a few atoms of hydrogen or a few simple organic radicals, or they may differ only in being isomers or polymers. In many of these cases one compound can often be transformed into another by a few simple reactions.

Of the two great classes of plants—the non-flowering and the flowering—the former contain very few active principles, and those which do exist are far more simple than those which are found in the flowering plants. In the bacteria, to be sure, we have highly developed poisonous compounds, the toxalbumins, but aside from these there are few active principles in them. The simpler group of poisonous acids is here more abundant; there are few glucosides and still fewer alkaloids. The most prominent of the latter are ergotine from ergot and muscarine from the fly fungus (*Amanita muscaria*). There has been an immense amount of study done on the former, but its chemical composition is still in a most unsatisfactory condition. Trimethylamine, one of the simplest of the so-called alkaloids of the aliphatic series, is also present in ergot at certain stages of its growth. According to the definition of alkaloids now commonly accepted, however, neither trimethylamine nor muscarine is an alkaloid, this class being restricted to the benzol or aromatic series of compounds. Proceeding still higher in our grouping of plants we find that there are but two conspicuous alkaloids, toxine and ephedrine, in the lowest group of flowering plants, and that, in the many families of the next higher group, the monocotyledons, there is but one family, the Melanthaceæ, which contains more than one or two important alkaloids. In the highest group, however, there is a long list of alkaloids, arranged often in groups, characteristic of the family to which the plants belong. The atropine-like alkaloids of the Solanaceæ; the strychnine-like alkaloids of the Loganiaceæ; the morphine-like alkaloids of the Papaveraceæ; and the quinine-like alkaloids of the Rubiaceæ are the best well-known groups. There is a similar distribution of the glucosides throughout the plant kingdom, but these compounds, being simpler than the alkaloids, are found lower down in the plant scale. It is interesting to note, however, that throughout the whole list of the tremendously abundant family of grasses, one of the lowest families of flowering plants, there are but two glucosides, neither of which is at all well known. One of these is loliin, from the poison darnel, *Lolium temulentum*, while the other, setarain, was isolated from millet so recently as in 1899 by Prof. E. F. Ladd, chemist of the Agricultural Experiment Station at Fargo, North Dakota. The grouping of all plant constituents in accordance with their plant classification offers a tempting field of work, but this cannot well be undertaken to advantage until the identity and nature of a great many more plant substances have been determined.

Sohn's "Dictionary of the Active Principles of Plants" enumerates about 600 substances, all of which are included under the three commonly recognized classes of these bodies, viz., the glucosides, the amaroids or so-called bitter principles, and the alkaloids. These three classes do not, however, include all of the groups of toxic substances which are represented in plants. In addition there are mineral substances, which under certain conditions may be taken up by plants, acids, oils, enzymes and their closely-related congeners—the toxalbumins.

Mineral substances very rarely cause poisoning on account of their occurrence in plants, but it has been shown that the presence of lead in a certain grass has led to distinct symptoms of lead poisoning in cows that ate it. An exceedingly important problem suggests itself in this connection and that is the possibility of poisoning from the gradually increasing use of insecticides on fruit trees and on vegetables. It has already been pointed out that plants which have been manured with superphosphates, which frequently contain arsenic, may absorb arsenic into their tissues to such an extent that arsenic poisoning may result from eating them.

The great toxicity of prussic acid is well known. It occurs free in certain plants and in the form of a glucoside in several others, especially in those belonging to the rose and apple families. Oxalic acid is also present in the form of an acid oxalate in many plants. It is extremely poisonous. Crotonoleic acid, from *Croton tiglium*, is still more poisonous, the fatal dose being represented by only .38 of a milligramme per kilogramme of body weight. Poisonous acids are not so generally looked for in plants as they should be, and it is quite possible that the active principles of some plants, the chemical nature of which is still unknown, are acids. The effect of the common loco-weed of the Western States, *Astragalus mollissimus*, has been attributed to loco acid.

The medicinal and therapeutic effects of the vegetable oils are tolerably well known, but it is not commonly recognized that some are poisonous. Among the most powerful of these are the oils of chamomile, cloves, cinnamon, sassafras, savine, rue, heleoma and tansy. Many of these are commonly used as flavor and to preserve food, but it is certain that their excessive use might result in serious gastric disorders if not in death. All are useful on account of their being antiseptic, a property which was commonly recognized centuries ago by the Egyptians in embalming bodies. Nutmegs contain a volatile oil which is toxic; two of the nuts proved fatal to a young girl who ate them. The extreme toxicity of toxicodendrol, the non-volatile oil of the common

FIG. 5.—A YUCATAN FACTORY FOR THE SEPARATION OF HEMP FIBER.

* Address of the retiring president of the Chemical Society of Washington, April 10, 1902.

poison ivy, *Rhus radicans*, and poison sumach, *Rhus venenata*, has recently been shown by Dr. Franz Pfaff, of the Harvard Medical School, who proved that the hundredth part of a milligramme easily caused a severe dermatitis on many persons, while as little as the thousandth part of a milligramme caused severe itching of the skin and half a dozen vesicles on some persons, and localized œdema on others that were more sensitive to its effects.

The glucosides are well known. One of the most poisonous representatives of the group is the active principle antiarin, from the East Indian tree so well known to legendary history as "the deadly upas." Its juice has been used in times of war by savage tribes to envenom their arrows. It takes but one to two milligrammes of this glucoside to kill a moderate-sized dog in nine minutes. Frogs are killed with a hundredth of a milligramme in twenty-four hours. The results of a most interesting investigation on the poisonous constituent of a leguminous plant of Egypt, known botanically as *Lotus arabicus*, have been recently published by two English investigators, Messrs. Dunstan and Henry. Its seeds when ripe are commonly used as fodder, but the growing plant is quite poisonous to horses, sheep and goats. It was noted that when the dry leaves were crushed and moistened with water they gave off an odor of hydrocyanic acid. An investigation revealed the presence of a glucoside, lotusin, which was hitherto unknown. Under the influence of an enzyme, also present in the plant, the lotusin was transformed into prussic acid, sugar and a new coloring matter called lotoflavine. It will thus be seen that this glucoside is very similar in its properties to amygdalin and also to linamarin from common flax. These glucosides may cause poisoning when taken into the stomach but are innocuous when administered hypodermically, for in the latter case they are excreted unchanged, while in the former they are apt to be decomposed by the acids and enzymes of the stomach.

The class of amaroids has not been well investigated chemically, but we know several compounds belonging to the group which are extremely toxic. Cicutoxin is the poisonous constituent of the common water hemlock, *Cicuta maculata*, a plant which probably causes more fatal cases of poisoning in the United States than any other plant. Digitoxin, one of the poisonous constituents of the foxglove, *Digitalis purpurea*, is poisonous to cats in a dose of 0.4 of a milligramme per kilogramme of body weight, while andromedotoxin, the poisonous constituent of many Ericaceous plants such as the common laurel, *Kalmia latifolia*, and the rhododendrons, is still more toxic, being fatal to frogs and to birds in a dose of 0.1 of a milligramme per kilogramme when injected subcutaneously. But, as we shall see, it is much less fatal when fed to birds. It is much more fatal to frogs than is atropine or strychnine.

The alkaloids are so well known that they do not need much discussion here. Aconitine is one of the most poisonous, being fatal to birds in the small dose of 0.07 of a milligramme per kilogramme when injected hypodermically.

The enzymes are not very well known, and in most cases they are not toxic. Some of them are, however, capable of causing disorders when injected under the skin. Very closely related to these are the toxalbumins which embrace the most deadly of all of the poisons, as may be recognized from the fact that they are the poisonous constituents of the venom of snakes and spiders, of many pathogenic bacteria, and of the most poisonous fungi, such as *Amanita phalloides*. We shall have more to say about these substances later.

Nearly all of the active principles which have been isolated from plants have also been studied toxicologically, and have been classified in different ways, but chiefly with regard to the character of their effect and the organ most seriously poisoned. We thus have those which cause marked anatomical changes of tissues, those that principally affect the blood and those that do not cause any marked anatomical lesions. The fatal dose, also, has in many cases been established, so that we can often tell how much of a given substance will kill a given animal in a given time. In this determination it is absolutely necessary, of course, that the animal tested be a healthy one, otherwise a fatal lesion may be produced by the poison simply on account of the previous weakening of the affected tissue by the disease. The time and dose limitations of poisoning are not essential in our accepted definition of a poison, for it considers only derangements of function. If these are produced even by commonly edible substances, such as sodium chloride or sugar, we are obliged to say that under the special conditions of the case in hand these substances are poisonous. Sugar is thus poisonous to a diabetic patient, while pure salt when fed regularly even in normal quantities would undoubtedly prove fatal if all other salts were withheld from the food for a considerable time; half teacupful doses of the saturated solution are said to be sometimes taken by the Chinese to commit suicide. This elimination of the time and dose elements makes it very difficult, sometimes, to distinguish poisonous substances from foods, but it is eminently satisfactory because it calls for subsequent explanation showing in what way and to what extent a substance is toxic. It calls more forcibly to mind, also, the danger in the continued use of drugs and of such narcotics as tobacco and hasheesh, and also to the flagrant and outrageous use of antiseptics in such foods as milk and bread which are consumed daily, sometimes in large quantities. Who can say how much material damage is done to the progress of civilization by this criminal practice? Until proven to the contrary, it ought to be taken for granted that any substance which has antiseptic or germicidal value is also capable of exerting these properties in a deleterious way in the human body, especially when the substance is ingested frequently for a long period of time. The Spanish people are said to be a race of dyspeptics because of their inordinate use of condiments; let us pray that the American people will never become degenerate on account of the use of the antiseptically preserved food which is too often sold in our markets.

There are 16,673 leaf-bearing plants included in Heller's "Catalogue of North American Plants," and of these there are nearly 500 which, in one way or another, have been accused of being poisonous. This does not, of course, mean that any one part or all of each of these plants would be fatal if eaten by man or by any one kind of an animal, but simply this, that some part or parts of each, at some period of the plant's growth, contain an active principle which is capable of causing death or some serious derangement of function in one or more forms of animal life when administered in a certain way, not necessarily by way of the mouth. Snake venom is none the less poisonous because it can be swallowed with impunity in considerably more than what would be a fatal dose if injected into the skin in the natural way through the serpent's fangs; neither is the death cup, *Amanita phalloides*, to be considered non-poisonous because it has been eaten after the poison was extracted by chemical methods. Other plants may be eaten with other things which will either enhance their poisonous effect, as in the case of amygdalin when an amygdalin-splitting ferment is also consumed, or counteract it, as might be the case when other medicinal plants are eaten; others again may be considered non-poisonous because the active constituent may be removed or destroyed from the plant by boiling or by drying; and finally others may be declared innocent because the poison is not present in the part consumed, or is present only at certain brief stages of growth; the amount present might also have been increased or diminished according to the conditions of growth or cultivation of the plant, as is most commonly the case in those which are cultivated for their medical value.

We cannot take time to even mention all of the unsolved problems which have arisen in connection with all of these suspected plants, but there are several interesting questions in connection with the variable amount of poison present in a plant, its variable location in the plant, and especially the variable effect upon animals, that should receive special attention.

Few poisonous plants are of sufficient commercial importance to have been investigated chemically with anything like the detail necessary in order for one to draw definite conclusions in regard to the development of their poisons, or of their location in the plant, but all druggists and physicians are aware that the chemical compound by virtue of which a drug is of therapeutic value is almost invariably more abundant in one part of a plant than in another. The same is true of all plant compounds. The variability of cultivated drugs in their contents of active principles was alluded to above. A more satisfactory example of how artificial environment can affect the chemical constituents of plants may be found in a bulletin recently published by Dr. H. W. Wiley, Chief of the Bureau of Chemistry of the Department of Agriculture, and entitled "The Influence of Environment upon the Composition of the Sugar Beet." In this bulletin it is shown that the factors which determine the maximum yield of sugar are as follows: high latitude, free use of fertilizers, and an even distribution of a rainfall of from three to four inches during the months of May, June, July and August, and a reduction of rainfall for September and October.

Natural environment affects some poisonous plants in a similar way, but in this case the more southerly plants are apt to have a greater development of the active constituents than those further north. This is particularly noticeable in the Indian hemp, *Cannabis sativa*. The plants of the Southwest contain a larger quantity of the active principles than the more northerly ones do. A striking example of the possible diurnal variation of the amount of poison in the leaves of plants is shown in a very instructive investigation by Dr. J. P. Lotsy of the cinchona plant. The author showed that the quantity of alkaloids varied greatly in the leaf as taken by day or night and on sunshiny or cloudy days, being most abundant in the first instance in each case. He showed also that these alkaloids are formed in the leaves during the day and are almost wholly deposited in the branches or bark at night. If gathered in the early morning therefore cinchona leaves would be practically inert, while if gathered in the evening, especially on a sunshiny day, they would be in their most active condition. The foliage is, in general, the part of a plant which causes most cases of stock-poisoning. The period of leaf maturity is regarded by some cultivators of medical plants as being the time at which its chlorophyl content is most highly developed, or when the leaves are most intensely green. This is generally soon after the flowering time in the case of herbaceous plants, but with some, such as the aconite, the purple larkspur and the poison camas of Montana, and many bulbiferous plants closely related to the last, it is earlier, the leaves of some of these having commonly dried up before the plants have flowered. In such cases the leaves would naturally be most active physiologically if eaten before the plants blossom, and might be practically inert at other times. Such is probably the case with the purple larkspur and death camas just referred to. The active principles are sometimes found most abundant in the most rapidly growing parts of the plant, as in the white sprouts of potatoes, and again they are to be found in parts which have been fully developed, as in the case of sapotoxin in the corn cockle, *Agrostemma githago*. It has recently been shown that in aconite seeds the central parts contain most of the aconite, while the seed coats are free from it. In the calabar bean the very poisonous alkaloid eserine is found in the cotyledons. In the seeds of the common jimson weed and black henbane the alkaloids are located chiefly in the layer beneath the epidermis; the epidermis itself and the seed covering of each are free from alkaloids. In jimson weed the quantity of alkaloids in unsprouted seeds was found to be fifteen times as great as in sprouted seeds, and in the seedlings of the jequirity bean, *Abrus precatorius*, it has been definitely shown that most of the toxalbumin is retained in the cotyledons. In growing colchicum the percentage of alkaloid is high in the growing tips and comparatively low in the lower part of the bulb. The first year's crop of leaves of foxglove and of henbane is inferior to that of the second on account of the smaller quantity of active principle. The variation in strength of the powerfully poisonous drug known as strophanthin is so well known to physicians that its medical use is being abandoned. Many such instances might be cited, but these show the importance of knowing the entire history of a plant in testing its character as poisonous or non-poisonous.

There are several molds and smuts which often infest corn and fodder. We know that some of these, when eaten or inhaled, sometimes cause death in a mechanical way by clogging up the system by their growth within the body, but there is much reason to believe that some of them contain poisons which are either consumed with the mold or are generated *pari passu* with the growth of the mold in the body. Probably some of these compounds like the sulphocyanic acid of *Aspergillus niger*—a weak poison—are absorbed with difficulty, especially when taken into the stomach, and this may be the reason why the plants are often eaten with comparative impunity. But are there not conditions when a greater quantity of toxic substances may be present in them, or may there not be a condition of the system in which the poison is more easily absorbed? The large number of cases of stock-poisoning said to have been caused by molds and smuts demand an extended investigation.

Another problem which is essentially of the same nature is in connection with the large polymeric group of saponin-like glucosides. These substances are, as a rule, not very poisonous when taken into the stomach, but it is a noticeable fact that few of the many plants which contain them are eaten by animals. Some are, however, eaten both by the lower animals and by man, as is the case with the fruit of the Moreton Bay chestnut or bean tree, *Castanospermum australe*, of Australia. Some persons assert that this fruit is edible, others that it is merely indigestible, while still others are emphatic in regard to its deleterious effect upon man. Nearly all of the saponins are difficult to dialyze, so it is quite probable that when taken into the stomach they are ordinarily excreted before they can accumulate in sufficient quantity in the blood to cause symptoms of poisoning, but in other cases where poisoning has resulted it seems probable that some condition of the digestive tract, perhaps ulceration, has facilitated the absorption of the compound into the system, where it at once exerts the same powerful effect that it does when injected hypodermically.

Some animals are, for various reasons, entirely immune against the effect of certain poisons. This difference in susceptibility is, in general, correlated to the mental development of the animals compared. The brain and nerve poisons, such as morphine and atropine, are much less poisonous to animals than man. Dogs and horses can, in proportion to their weight, endure ten times as much morphine as man, while doves can stand 500 times and frogs even a thousand times as much. In herbivorous animals, especially in those which chew their cud, such as sheep and cattle, the digestive tract is much longer than in the case of omnivorous or carnivorous animals, consequently the food remains in the body for a much longer period. In case of herbivorous animals this period is usually several days, while in carnivorous animals it is about twenty-four hours only. In the former case, therefore, the poison would have much more time to become absorbed into the blood than in the latter. This, according to Fröhner, probably explains why it is that the metallic poisons are much more fatal to herbivorous than to carnivorous animals.

The flesh of an immune animal to which a large dose of poison has been administered is apt to be poisonous to other animals that eat it if they themselves are not immune to its effects. For example, it is asserted that advantage is taken of this fact in our Southern States in feeding strychnine to chickens in order to poison the hawks that prey upon them. Cases of human poisoning may inadvertently occur by thus eating the poisonous principles of plants which are present in the honey, the milk or the meat derived from certain plants.

All grades of merit or flavor are attributed to the honey derived from plants, thus indicating that the chemical constituents which give characteristic odors and tastes to flowers are often transferred directly to the honey derived from them. Some of the undesirable constituents of nectar are probably eliminated by the bee in some little-known way, and other portions are perhaps selectively retained. Formic acid is a poisonous substance which is found as an apparently essential constituent in all honey, but as it is present only to the extent of about three grains per liter it does not produce toxic effects. Gelsemine, the poisonous constituent of the southern jessamine, *Gelsemium sempervirens*, is said to have been found in honey from Branchville, South Carolina, and andromedotoxin has lately been found in honey from *Rhododendron ponticum* of Europe. The most convincing proof that poisonous honey may be derived from rhododendrons and that its toxicity may be due to andromedotoxin has been furnished by Plugge and Thresh. The former has obtained the poison from the nectar of *Rhododendron ponticum;* the latter found it in 1887 in a sample of honey from Trebizond.

Cases of poisoning from milk are more apt to happen nowadays from the use of preservatives and from bacterial toxines rather than from any other causes, but cases arise from milk becoming sour while in metallic containers or from the plants eaten by an animal. The effect of garlic on milk is well known, but it is not so well known that cabbage and turnips also give milk a bad taste. Chicory imparts a bitter flavor to milk and dyer's weed, *Genista tinctoria*, is said to make the butter and even the cheese made from milk derived from it very unpleasant to the taste. Kobert states that children have been killed by the milk of goats that had eaten colchicum or the broom plant. In my "Preliminary Catalogue of Plants Poisonous to Stock" mention was made of a severe case of poisoning which was due to drinking milk from a cow that had been feeding on mandrake, and investigation made by Dr. E. V. Wilcox and myself in Montana show that lambs are frequently killed by

sucking milk from their mothers after these had eaten death camas, *Zygadenus venenosus*. It was a common impression throughout various districts in the South only a few years ago that the disease known as "milk-sick" was due to milk from cows that had been eating poisonous plants. This problem has never been solved, although the disease is still reported occasionally. Other cases of such poisoning are comparatively rare, but two have recently been reported to the Department of Agriculture, one from Nebraska and another more important one from the Pecos Valley in New Mexico. The butter and cheese were also suspected in the latter case.

The interest in connection with poisonous honey is both theoretical and practical; that with poisonous game is, perhaps, only theoretical, since no cases have been called to public attention for many years and the records of past cases are few in number. To determine whether the flesh of a bird or animal that has eaten a poisonous plant is poisonous or not it is necessary to prove: First, that the birds or animals in question may eat the suspected plants with impunity to such an extent as to render their flesh poisonous; and secondly, that, perhaps under stress, they actually do so. This latter point can be solved only by the close study of actual cases. An attempt was made by the writer a few years ago to examine into the former question, especially in connection with some historic cases of poisoning, supposed to have been due to eating partridges which had fed on mountain laurel, *Kalmia latifolia*. It is true that partridges eat laurel leaves in winter, and that they may not be poisoned thereby. I have seen as much as 14 grammes of the leaves taken from the crop of a single partridge, yet this bird was eaten without any ill effect arising therefrom. In this case, however, the leaves were still in large pieces, many of them being over a half inch square. The andromedotoxin was, therefore, not extracted, and, unless the bird's previous meal consisted of the same food, its flesh could not have contained much of the poison. Andromedotoxin was fed for several days in gradually increasing doses to a chicken, which, at the end of the fourth day, had received a very large dose without affecting it at all seriously. The chicken was then killed, cleared of entrails, boiled for a half hour and fed to a cat with the result that it was very badly, but not fatally, poisoned. Similar problems might be suggested in connection with the poisonous plants eaten by game animals, and especially in connection with the edibility of fish caught for food by the use of plants thrown into the water to stupefy and poison them. Some detective work, also, is desirable to determine to what extent poisonous plants are clandestinely added to whisky and other alcoholic beverages to increase their intoxicating effect. It is reported that in some country districts throughout the South use is thus made of the leaves of mountain laurel and other andromedotoxin-containing plants.

The practices above mentioned suggest another subdivision of my paper, and that is the effects of the habitual use of narcotic plants. In the United States this use is confined mainly to tobacco smokers, but it is interesting to note that the use of Indian hemp is spreading throughout the Southwest, where it was most probably introduced from Mexico. The effect of this drug is well known from accounts published in the daily press and elsewhere. The common Mexican name of the plant is *mariguana*, but this name is also applied in some parts of Mexico to a native *Datura*, *D. meteloides*, much like our common jimson weed. Both of these plants and others, such as the tree tobacco, *Nicotina glauca*, are sometimes called locoweeds in Mexico. "Loco" is a Spanish word which, in its original sense, means mad or crazy. Of late, however, it has been extensively applied, especially in northern Mexico and the United States, to certain plants which so affect the brain of animals that eat them as to cause chronic derangements of the power of thinking and of co-ordinating movement. It is, however, most popularly applied to several weeds —*Astragalus* and *Aragallus* spp.—of the bean family, which cause a peculiar kind of insanity in animals that eat them. It is not uncommonly asserted by Mexicans that sometimes a single dose of hemp will cause long-lasting insanity. Van Hasselt, a Dutch authority on poisonous plants, also asserts that a single dose of this drug may cause mania for months, but the best pharmacologists are agreed that such might be the case only when the person affected is already badly diseased by the use of drugs or otherwise. There is reason for skepticism here, especially in regard to the crazing effect of single doses, but it is highly desirable that the subject be inquired into to find out how little of any one plant can cause insanity in a short time. With the true locoweeds of our Western prairies I am satisfied that at least several days' feeding is necessary to produce any bad effect. The Department of Agriculture is at present engaged in an investigation of the curious behavior of these weeds.

The question of disease-producing food presents many important problems closely related to those mentioned above. Aside from the study of locoism there are such problems as the relation of ergotism to the ergot of rye; of lathyrism to the seeds of the species of *Lathyrus* and *Vicia*, both commonly represented in our native flora; of the so-called "bottom disease" of Missouri and the seeds of the rattlebox; of githagism to the seeds of the common corn cockle which is abundant in the wheat fields of the middle Northwest, and also to the spring cockle, *Vaccaria raccaria*, which is also becoming common in the extreme Northwest, and finally the relation of dry food or of dry moldy foodstuffs to blind staggers or cerebro-spinal meningitis and the so-called cornstalk disease of the middle Western States.

The toxic theory of disease is by no means a new theory, for Albrecht von Haller advanced it about the middle of the eighteenth century in connection with the extracts of putrefying animals, but it has received proper prominence only lately in connection with the toxalbumins, the first of which to be described was "echidnin" or "viperin." This was extracted in 1843 by Prince Louis L. Bonaparte, from the venom of vipers. Crotalin, the poison of the rattlesnake, was described by Dr. S. Weir Mitchell, an American, in 1860. But it was not until after 1884, when two English chemists, Warden and Wadell, isolated abrin from the seeds of jequirity, *Abrus precatorius*, that these bodies were closely investigated in plants. Since 1884 ricin has been isolated from the castor-oil bean, crotin from a bean of the same family, phallin from the deathcup fungus, *Amanita phalloides;* and robin from the bark of the common locust. From many pathogenic bacteria and from some poisonous spiders similar compounds have been isolated. All resemble ordinary albumen in being coagulable by heat and all are remarkably poisonous, but death often ensues only after several days when the poison has been taken internally. After these substances once get into the blood there is no established method of offsetting their effects. There is, however, a most interesting method of preventing and perhaps offsetting their effect which is bound to come more and more into general use. I refer to the use of blood serum and to the various artificial ways of producing immunity or a high degree of tolerance.

Ehrlich, a German investigator, first showed in 1891 that animals can be made to endure very large doses of two plant toxalbumins, abrin and ricin, and, in 1897, Cornevin showed that by heating ricin to a temperature of 100 deg. C. for two hours a substance is formed which, when injected two or three times under the skin of hogs, ruminants or chickens, will produce immunity against the effects of ricin for several months. The essential factor of success in combating these poisons within the body seems to be the development of an increased number of white blood corpuscles within the body. It has been experimentally proven that these corpuscles are not only capable of attacking the destroying bacteria, but also of destroying toxic substances present in the body, the chemical reaction involved being probably an oxidation. These bodies contain an oxydase or oxidizing ferment, and it is known that such oxidizing bodies as permanganate of potash and chloride of lime easily oxidize most if not all of the toxalbumins and thus render them harmless. Any substance, therefore, which is capable of developing a larger number of white corpuscles in the body would serve as a kind of antitoxine against these poisons and it would not appear to be necessary that each particular toxine should have a separate antitoxine. Indeed, experiments show that antitoxines are not chemical antagonists to toxines, but act simply as stimulants to the body to manufacture its own antidote. Certain chemicals, such as sodium hypochlorite and nuclein, an albuminoid obtained from cæsine or from beer yeast, stimulate the production of these cells, and these substances may, therefore, be looked upon as antitoxines. Whether or not these substances will also stimulate the white corpuscles or the other oxidizing organs of the body so that they will offset the effect of plant poisons is a problem which is yet to be solved. It is not known how many poisons the leucocytes are able to destroy in the body, but if their action is really in the nature of an oxidation we may assume that all poisons which are harmless when oxidized, as plant poisons are apt to be, would be destroyed by them whenever they gained access to the blood, provided, of course, that the leucocytes were in sufficient abundance to do the work. We see then the great importance both from the poisonous-plant point of view and for general prophylactic effect against disease of building up an animal's system so that it will contain a maximum quantity of leucocytes. It is probably impossible to stimulate the formation of leucocytes so rapidly that the process would be available for immediate treatment in cases of acute poisoning, but, since it requires only four or five days to produce immunity to snake venom by repeated injections of a dilute solution of the chloride of lime, it might possibly be useful in chronic cases where the poison concerned is harmless when oxidized.

A particularly interesting phase of oxidation in relation to germicidal action has recently been investigated by Profs. Freer and Novy at the University of Michigan. Their preliminary paper shows an interesting comparison of the germicidal effect of:

Hydrogen peroxide .....H—O—O—H.
Benzoyl peroxide ....C_6H_5CO—O—O—COC_6H_5.
Acetyl peroxide .....CH_3CO—O—O—$COCH_3$.
Benzoyl acetyl perox.C_6H_5CO—O—O—$COCH_3$.

It will be noticed that the three organic compounds are symmetrical like that of hydrogen peroxide. The amount of available oxygen in each compound is the same but the germicidal action of each varies greatly. The use of hydrogen peroxide as a germicidal agent, especially in strong solution, is well known. Benzoyl peroxide is almost insoluble in water and is not hydrolyzed; it is, therefore, of no value as a germicide. The last two compounds have no germicidal value of themselves, but they are readily hydrolyzed in the presence of water yielding benzo peracid C_6H_5CO—O—OH, and aceto peracid CH_3CO—O—OH, both of which have a very marked germicidal value. These organic peracids or peroxides are, according to the authors, at least several hundred times more active than is hydrogen peroxide. The active oxygen content is the same in each, so that the difference in effect cannot be due to nascent oxygen. Hydrogen peroxide loses its available oxygen readily and even violently on contact with enzymes, but these organic peroxides do not. The authors were, therefore, forced to the conclusion that the difference in action is due to the behavior of the acid ions. In this case, therefore, it is the benzoyl and the acetyl ions and not the oxygen which does the germicidal work.

In close connection with this investigation there is another recent piece of work suggestive of important problems In connection with the chemistry and physiology of plant poisons which I wish to allude to before closing, and that is the paper by Dr. A. P. Mathews entitled "The Nature of the Nerve Impulse," published in the March Century. This treats of nerve stimulation and nerve paralysis on the basis of our modern theories on the nature of solution, a trend of investigation now being carried on at the Hull Physiological Laboratory of the University of Chicago under the direction of Dr. Jacques Loeb, Professor of Physiology at the institution. The author's conclusions are as follows:

"It has been shown: first, that the chemical stimulation of protoplasm is really an electrical stimulation; second, that the poisonous action of inorganic salts is due to the electrical charges of the salts and probably to the movements of these charges; third, that the negative charges stimulate protoplasm, while the positive prevent stimulation, and if not counteracted by the negative will destroy life; fourth, that muscle contraction is probably in its essence an electrical phenomenon and that the conduction of a nerve impulse is almost certainly an electrical phenomenon; fifth, for the first time we have a physical explanation which agrees with all the main known facts of the nerve impulse and changes in irritability; sixth, we have secured a physical explanation of the way in which an anesthetic produces its effect; seventh, we are led to the hypothesis of the identity of stimulation by light and by chemicals."

The author does not, in this paper, discuss the possible effect of the ions of plant poisons, but it is difficult to see if his theory really holds good for organic compounds, why the complex cathion of so many alkaloids should be so extremely poisonous, and one is forced to wonder how any acid ion could be found which could be powerful enough to offset the toxic effect. One is also tempted to wonder if death can be the complete physiological opposite of life, for is there not a tremendous difference between the automatically reversible character of the cell protoplasm which enables it alternately and in rapid succession to solidify and redissolve, and the simple irreversible solid or liquid state which is the result of death?

In the foregoing paper I have attempted briefly to discuss some of the practical, as well as some of the theoretical, features of plant poisons, throwing out suggestive hints rather than concrete problems here and there, and although I feel that the ground has not been adequately covered, I trust that at least some of you have been interested in the discussion, and I venture to express the hope that some of the suggestions have fallen on good ground and will result some day in a rich harvest of facts giving solutions to some of the problems suggested.

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RADIO-ACTIVITY OF THORIUM COMPOUNDS.

E. RUTHERFORD and F. Soddy find that the radio-activity of thorium compounds is the consequence of changes in which new types of matter are formed, and they conclude, therefore, that it is a manifestation of sub-atomic chemical change. Thorium, from which ThX has been separated, regains its activity with time, but the activity of ThX decreases and has almost completely disappeared when thorium reaches its maximum again at the end of three weeks. Emanating power appears as a property of ThX and not of thorium, and is proportional to the activity of the ThX present. The decay and recovery of emanating power of ThX and thorium are completely analogous to the decay and recovery of radio-activity. These results find their simplest explanation in the view that a secondary change is proceeding in ThX. One of the products is gaseous, and in the radio-active state constitutes the emanation. This change appears more allied to ordinary chemical reaction than the primary, for it is affected by the conditions. The residual activity of thorium would be explained if the chemical change which produces ThX produces also a second kind of active matter, closely allied to thorium in its properties. The radiations of this residual part are composed entirely of rays non-deviable in the magnetic field, whereas the other two components of thorium radio-activity comprise both deviable and non-deviable radiation, thorium being analogous to uranium in that respect. It is found that ThX possesses a distinct chemical behavior which differentiates it from thorium, ammonia being the only reagent of those tried capable of separating it from the latter. The amounts of ThX produced in varying intervals of time between successive precipitations agree with the requirement that ThX is being continuously produced by thorium compounds at a constant rate. The rate of production of ThX and the rate of decay of its activity are apparently unaffected by known agencies. Both changes proceed independently of the chemical and physical conditions of the molecule. The source of the energy required to maintain the radio-activity of thorium over indefinite periods is, therefore, to be found in a chemical change producing new types of matter.—Proc. Chem. Soc.

EGYPTIANS' EYE FOR NATURE.*

W. M. FLINDERS PETRIE, referring to the Egyptian artists of the Fourth Dynasty, says: "They did not make a work of art as such, but they rivaled nature as closely as possible."

Two figures—a bull and a deer—on the tablet of Mena, dating from the First Dynasty, or about 4700 B. C., the oldest written sentence yet discovered, afford a remarkable confirmation of the professor's statement, in regard to the knowledge and expression of motion by the sculptor of this age. A bull striving to attain his utmost speed is represented in a phase of movement which after a lapse of sixty-six centuries is reproduced in a photo-engraving illustrating some consecutive phases of the stride of a horse.

The phase employed by the Egyptian artist has been until recent years, very rarely used in art; the nearest approach to it that I can at this moment recall is in a fresco painting on the walls of the Campo Santo at Pisa, supposed to have been executed by Pisano. It, like the Mena tablet, illustrates a phase of the transverse gallop—a system of motion adopted by the horse, the ox and the greater number of animals, whether single-toed, cloven, or soft-footed, when they exert their utmost power to attain their highest speed.

In the lowest line of figures on the tablet is a deer, evidently jumping over an obstacle. The animal is represented with all its legs, flexed, in pairs under its body. A precisely similar phase may be found in a series, in the library of the British Museum, demon-

*From the London Times.

strating a jump which sometimes takes place in the rotary gallop of the deer, which system of motion is always used by the deer and also by the dog, when from caprice or necessity they endeavor to make rapid progress. This distinctive method of galloping was unknown, and, indeed, unsuspected by us moderns, until revealed by photographic investigation of animal locomotion; but it was apparently well known to the early artists of Egypt. EADWEARD MUYBRIDGE.

PRINTING STEREOSCOPIC POSITIVES UPON GLASS WITHOUT TRANSPOSITION.

AMATEURS in stereoscopy are daily becoming more numerous, and manufacturers have increased the supply of apparatus by constructing various sizes for stereoscopic negatives. We were among the first, says M. G. Mareschel, in La Nature, to employ and recommend the 2.25 x 5 inch plate and we have the satisfaction of stating that the best manufacturers are now constructing apparatus for this size plate. There are many, as we find from our correspondents, who do not know the reason why it is necessary to effect a transposition of the images in the positive.

To begin with, it must not be forgotten that the images are taken at different angles, and that, in order to get the effect of a relief, each eye must necessarily see the image of the object as if it were looking at the object itself, that is to say, at the same angle as each eye sees it in nature; but such cannot be the case unless the right eye sees the image taken with the right-hand objective and the left eye that taken with the left-hand one. To understand the meaning of the transfer of the pictures to obtain the desired result it is only necessary to examine the prints on the paper at the time it is raised from the negative after printing to determine their respective positions.

Let us select as a subject a military officer wearing a sword in its scabbard, and consequently on the left side. By examining the manner in which the negative was located or produced in the camera, it is easily seen that, in order to have opposite each eye the image that is proper to it, our subject must have his head downward and his sword at the right side. If we have made a transparent positive we shall be able, by turning it around the longer axis of the plate, to place the head upward, although the sword will not have changed position, but will be always on the right side of the subject. The method employed is, therefore, a bad one. Whatever be the kind of positive we have made, transparent or opaque, we shall be able to completely right the images only by causing the positive to turn around an imaginary axis at right angles with its plane and passing through it near a point located between the two images at the geometrical center.

But, although we thus completely right our two images, it is easy to see that we have caused the image taken by the left-hand object to pass opposite our right eye, and conversely. In order to bring things to their normal state, we are therefore led to separate our two images so as to give to each one the place that it is to occupy in front of the eyes. This is an operation that is often annoying, especially if the positives be made upon glass. We cut the negative, or else, with special frames, do the printing in two successive exposures. But there is a method, and it is the oldest of all, in which the negative is not cut and the positive is obtained in a single exposure. This is done by allowing the objectives to effect the inversion of the images, that is to say, by photographing the negative with a stereoscopic apparatus. At the time in which wet collodion was alone employed for making positives upon glass, it was impossible to operate otherwise; and the method therefore dates back to the early days of photography. Why has it been abandoned? Probably because we no longer find it convenient to do the printing by means of the pressure-frame. In fact, when it is necessary to arrange an apparatus, center the plate and focus for each positive, this becomes quite complicated. It is precisely in order to do away with all complications of this nature that M. Gaumont has constructed for his 2.25 x 5 inch "Stereo-Spido," a complementary apparatus to which it is adapted and which permits of doing the printing automatically. To this device he has applied the name of "Epanastrophe," a word meaning a "turning around upon again." The apparatus consists of two wooden boxes, *A* and *B* (Fig. 1, No. 1). The first of these, *A*, slides upon the Stereo-Spido at the location of the magazine; and upon the extremity left free, in a frame devised for the purpose, the negative to be reproduced is placed film downward. This arrangement is then placed in the second box, *B*, into which it fits accurately, and in which it is secured by hooks. In this position the objectives face two apertures formed in a horizontal partition, *S*, which divides the box into two parts. These apertures may be closed or opened by a slide actuated from the exterior by means of the rod, *D*. The rod for actuating the diaphragms rests upon a fork fastened at the end of a lever, whose outer end, *E*, extends beyond the box

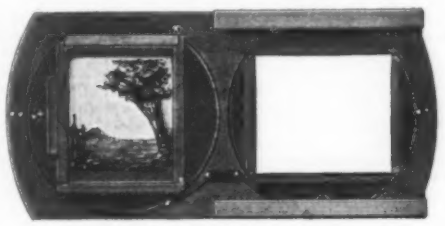

FIG. 2.—THE TURILLON FRAME FOR PROJECTIONS IN TWO DIRECTIONS.

so that the diaphragms also may be actuated from the exterior.

Into the lower part of the second box is slid the magazine of the Stereo-Spido, *M*, previously filled with special sensitized transparency plates.

The operation is then performed as is usually done with enlarging cones; and it is possible rapidly to print all the plates of the magazine merely by taking time to change the negative after each exposure. The apparatus is so arranged as to give a positive image of the same size as the negative. The question of the time of exposure is the only one that presents any difficulty; but this is easily ascertained after a few trials. Moreover, M. Gaumont has devised an arrangement that permits of solving it once for all for a series of negatives. It suffices to standardize the latter in starting with the densest, for example. To accomplish this the magazine is displaced by a sheet of ground glass, and one of the diaphragms is disconnected from the operating rod so that the lever, *E*, shall actuate but a single one of them, the other being left wide open. This done, one of the images of the standard negative, the densest of the collection, is placed opposite the non-diaphragmed objective, and then the images of the other negatives are made to pass in succession before the other objective; and the diaphragm is actuated every time until the same intensity is obtained upon the ground glass for the two images that are seen thereon. The numbers, indicated by the scale placed near the lever, *E*, show how much shorter exposures must be made of the negatives under trial than of the standard or type negative. Although the method is not absolutely accurate from the view point of mathematics, it is sufficiently so in practice to prevent differences in the time of exposures that would prove inimical to the final results.

Following the same ideas, Mr. Guillon, whose low-priced enlarging cameras are well known, has constructed an analogous arrangement for printing the positives of a small 2¼ x 5 inch camera of which he is the manufacturer. In making the positives, by a slight enlargement, two images 2⅝ x 2¾ inches are obtained. In order that the advantages of this mode of printing may not be limited to a single type of camera he adapts the system to any camera for which it is suitable. In Fig. 1, No. 2, we represent such an adaptation with a view to the utilization of a Jeux "Stereo-pochette." After the back, *D*, of the latter has been opened, it is slid into a box, *A B*, upon which is placed the negative carrier, *P*. A board, *O*, containing two apertures serves as a shutter; and the plate to be exposed is placed at *C* at the lower extremity of the box, *B*.

The dimensions almost universally adopted for the positives designed for lantern slides are 3¼ x 4 inches. The frames or slide holders adapted to the lanterns are always so arranged that it is impossible to place negatives therein in any other direction than widthwise, although there are many subjects that would be more effective if projected upon the screen lengthwise or upright. When it is desired to project a picture with its longest side vertical, it is necessary to reduce it in order that the subject may be vertical, the only position in which the slide can be placed in the holder, while in most cases it could be easily made to occupy the contrary position without reduction. As this is a constant source of annoyance to those who are engaged in making lantern slides, it has occurred to M. Turillon to remedy the matter by constructing a more common-sense slide holder. In this holder he mounts the frame designed to receive the negative upon a disk (Fig. 2) set into a recess in which it can freely revolve. A button fixed at the side of this disk permits of turning it 90 deg., while it is arrested in any position desired by means of a spring that enters a notch formed in the circumference. A slight pressure permits of easily moving the disk from one position to another at the moment of sliding the negative into the lantern. There is no time lost, and the views may be presented in the most favorable position.

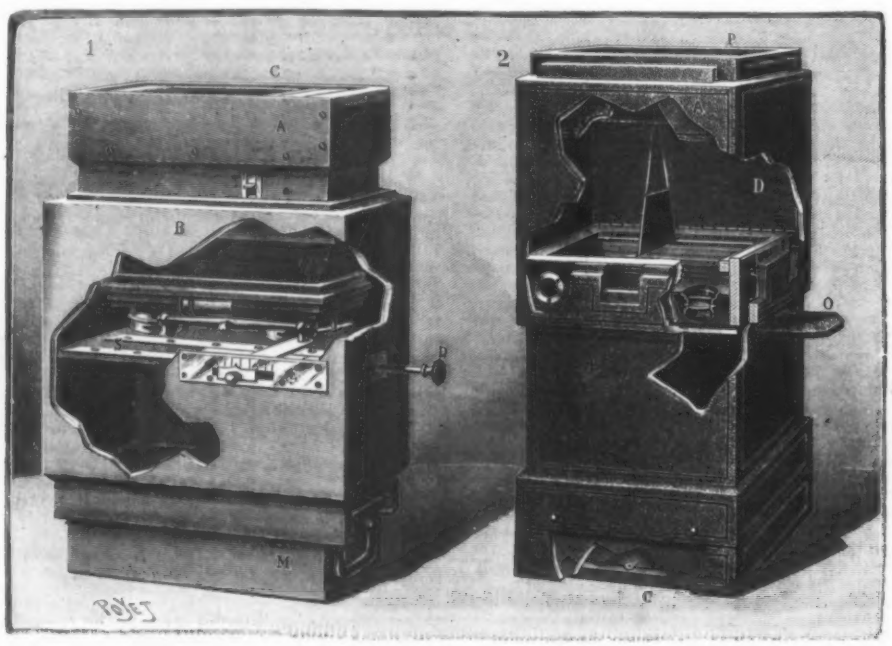

FIG. 1.—1. THE GAUMONT EPANASTROPHE FOR PRINTING STEREOSCOPIC VIEWS UPON GLASS WITHOUT TRANSPOSITION. 2. THE GUILLON APPARATUS FOR THE SAME PURPOSE.

PREPARATION OF NEW ELECTROLYTES, WITH BASE OF CARBONATES DISSOLVED IN ORGANIC ACIDS, AND CHLORIDES, OR ORGANIC ACIDS AND ALKALIES.

THE aim of the process is the formation of slightly acid baths, or very constant alkaline baths, not liable to decompose, by reason of the principle underlying the new method of preparation, which consists in the utilization of metals for electrolyzing, in the form of carbonates instead of salts, such as chlorides, sulphates, nitrates, acetates and others, which no longer enter into the constitution of the baths except for the conversion into carbonates.

All the salts employed in forming the baths have a base of mineral acids. The acidity of the baths is neutralized by adding half their weight of sodium carbonate. Thus an incomplete carbonate is obtained by making use of a solution of a salt, and a solution of half this quantity of carbonate of soda, of ammonia or of potash. These two solutions are thoroughly mingled for the purpose of obtaining a precipitated carbonate of the metal of the salt in question, which is recovered by washing and filtration, so as to drive off all excess of chloride, if chlorides are operated on, or the corresponding excess, if nitrates, sulphates, acetates, etc., are employed.

As this first operation, that is, the conversion into carbonate, is the same for all the salts, when the precipitate of carbonate is obtained, the preparation of the baths is characterized for all the metals by the solution to saturation of the precipitated carbonate in the liquid designed to form the bath, and holding in solution certain determinate proportions of an organic acid.

In practice the following proportions are suitable for the various ingredients: Liquid of the bath, 75 per cent; carbonate precipitate, 15 per cent; organic acid, 7 per cent; and ammonium, potassium or sodium chloride, 3 per cent.—Patent of M. Marin. From the French.

WHY IS NEW BREAD INDIGESTIBLE?

NEW bread is commonly considered indigestible, and with reason; but, according to an editorial writer in the Lancet, it is not necessarily so. Hot rolls when masticated properly should not offer any difficulty to the digestive organs. The writer goes on to say:

"A slice of stale bread on being broken with the teeth resolves into more or less hard gritty particles which, unless they were softened by the saliva, would be almost impossible to swallow. The particles would irritate the throat and the gullet. The fact is, therefore, that man is compelled thoroughly to masticate and to impregnate stale bread with saliva before he swallows it. This act, of course, partially digests the bread and thus makes it in a fit state for digestion and absorption farther on in the alimentary tract. This is why stale bread appears to be more digestible than new bread. New bread, on the contrary, is soft, doughy, or plastic, and there appears to be no necessity to soften it with saliva, hence it escapes the preliminary digestive action of the ptyalin of the saliva. New bread, in other words, is in reality 'bolted,' and 'bolting' accounts for many of the ills arising from dyspepsia. Accordingly, hot rolls should be enjoyed for breakfast without any fear of dyspepsia so long as the bread is good and so long as pains are taken to masticate it thoroughly."

The writer calls attention to the fact that a dog will "bolt" a piece of meat, but, when eating a piece of bread, he will keep it in his mouth some time and will almost labor over it before swallowing it. The dog, we are told, thus teaches a very important physiological lesson. There is very little that the mouth can do in the way of digesting meat, beyond reducing it, by means of the teeth, to a convenient form. But the case is different with bread. The writer continues:

"It is a curious fact that stale bread is not more dry than new bread, for on submitting stale bread for a short time to a high temperature it regains its condition of newness and becomes soft or plastic, and this in spite of the fact that some moisture is of necessity driven off in the operation. It is probable that in new bread there is free water present, while in stale bread the water is still there, but in a condition of true chemical combination, and it is this combination which compels us thoroughly to moisten and to masti-

cate stale bread before we consign it to the gastric centers. Similarly, the indigestibility of the Norfolk dumpling is probably due to the fact that it is of tough, doughy consistency and therefore should receive considerable mastication before it is swallowed. It is a sound physiological plan, therefore, to adopt—as it is said the late Mr. Gladstone adopted—the habit of chewing each morsel a great number of times."

THE ELECTROLYTIC PRODUCTION OF CHLORATES.

By JOHN B. C. KERSHAW, F.I.C.

THE manufacture of chlorate of potash has been carried on by the National Electrolytic Company at Niagara Falls since 1898, the cell originally used being that patented by Franchot and Gibbs in the year 1893. The details of this cell had been worked out at Buckingham, near Quebec. Its chief distinctive feature was the use of wire gauze cathodes covered with cuprous or cupric oxide. The reaction between the hydrogen gas liberated at the cathode surface and these oxides produced heat, and thus helped to maintain the temperature of the cell at 50 deg. C. The conversion of the hydrogen gas at the moment of its liberation into water also prevented secondary reactions between the hydrogen and hypochlorite or chlorate, with consequent loss of current efficiency. The cell, in a trial run of two months, is said to have yielded 4.386 pounds chlorate per electrical horse power day of 24 hours. Assuming that an E. M. F. of 5 volts was used between each pair of electrodes, this yield represents a current efficiency of 81.7 per cent, and is a marked advance upon the earlier figures published for the Gall and Montlaur cell. The disadvantages attending the use of copper oxides as anode material, however, were found in practice to more than counterbalance the gains due to higher current efficiency, and the cell now used at the Niagara works of the National Electrolytic Company is a modification of the original form, and is protected by English patent No. 393 of 1901. Fig. 1 is a vertical section of this cell, and Fig. 2 a plane elevation at right angles to Fig. 1.

Each cell is made up of a frame of wood or other suitable material, *A*, covered with some metal, *B*, such as lead, not attacked by the electrolyte. The cathode is formed by a series of vertical wires, preferably of copper, *C*, kept in position by cross bars of any insulating material, *O*. Its position and form is best understood by a reference to Fig. 2. This composite wire cathode is placed in vertical position against one side of the frame of the cell, and is kept in position by the anode of the next cell, from which it is insulated by strips of some insulating material, *F*, and the cross bars, *O*.

The opposite side of the cell from that occupied by the wire cathode is partially closed by the anode (see dotted lines in Fig. 2). This consists of a thick metallic plate, *D*, preferably of lead, covered with platinum foil, *E*, on the *outer* side. This anode plate is held in its vertical position by the cathode and framework of the next cell. *G* is a supply pipe reaching to the bottom, by which potassium chloride solution is fed continuously into the cell, and *H* is the run-off pipe, by which the mixed solution of chloride and chlorate, and the hydrogen gas are conveyed away from the cell. *L*, *L*, *L*, *L* are projecting lugs to the wooden framework, by means of which any number of cell units can be bolted together to form a composite cell. Fig. 3 shows such a group of five cells, the two heavy metal plates, *J* and *K*, being used to close the ends of the wooden framework, and to form a fully inclosed electrolytic cell, with openings to each unit at *G* and *H*.

The current connections are shown in Fig. 3, only the two terminal electrodes, m_1 and m' being connected to the positive and negative mains respectively.

When in normal work, the cell is continuously fed by each of the supply pipes, *G*, with a solution of potassium chloride, the rate of feed being regulated so as to maintain the temperature of the cell at 50 deg. C., and the percentage of chlorate in the electrolyzed solution under 3 per cent. The current connections are made at m_1 and m', and the composite cell then operates as a set of five cells, the electrical connection between the successive pairs of electrodes being provided by the metallic lining of the wooden frames, against which the electrodes are clamped. Where the insulating strips, *F*, separate the electrodes the current, of course, passes through the electrolyte, and the thickness of these insulating strips, *F'*, and of the insulating rods, *O*, which hold the copper cathode wires in position, thus determining the distance separating anode and cathode. This is seen to be small, and the patent specification recommends ¼ to 1-16 inch. The fact that the cathode is not a solid plate, as might appear from the study of Fig. 1, but is a collection of copper wires, permits an interchange to occur between the electrolyte on the two sides of the cathode; and all the solution passing through the cell in an upward direction may be supposed to participate in the electrolytic and chemical actions occurring in the narrow space between the two electrodes at the left-hand side of each cell interior.

Cells 26 inches by 18 inches, with a thickness of 3 inches for the framework, are found to work well in practice, the electrodes in these being placed ¼ inch apart. On account of the low percentage of chlorate in the liquid flowing from the cell, refrigeration is necessary in order to recover it, and Fig. 4 is a diagrammatic representation of an electrolytic chlorate plant using this form of cell. *T* is the supply tank, containing the potassium chloride solution; *P*, the electrolyzing cells at a lower level; *Q*, *Q*, the refrigerators for extracting the chlorate crystals, and *S*, the pumping machinery for returning the exhausted electrolyte to the storage tank.

The patent specification relating to this cell contains some claims which it would be difficult, if not impossible, to justify. Thus it is asserted by the patentees that they have *discovered* a method of working with a high-current efficiency, based on quick removal of the chlorate solution from the cell. The fact that chlorate and other intermediate products arising from the electrolytic decomposition of chloride solutions, were themselves decomposed by the current, has long been known, and it is no new *discovery* that working with a rapid flow minimizes such losses. The real difficulty is to find the point at which the highest economy is possible. Solutions containing 10 per cent chlorate of potash will crystallize on cooling without artificial aid; solutions containing only 3 per cent will not. Under certain conditions of manufacture it

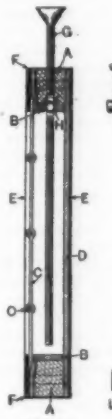

FIG. 1.

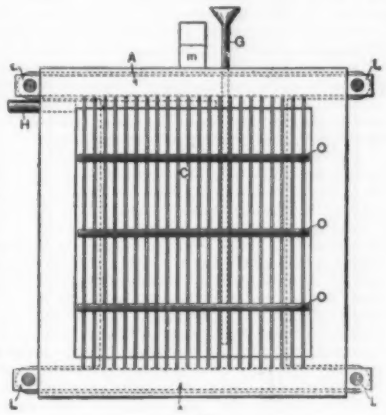

FIG. 2.

may be more paying to work with weak solutions and to adopt refrigeration; but to call that a discovery, and to base a patent claim upon it, is certainly absurd.

A second *discovery* claimed in this patent is that chlorates can be produced in an electrolytic cell without the aid of a diaphragm to separate the anodic and cathodic compartments of the cell. Charles Watt discovered this fact, if anyone did, and the patent in which his discovery is made public is dated 1851. The American patentees are, therefore, just half a century too late. The method has been adopted in many existing chlorate works, and there are now more cells of open (non-diaphragm) type operating

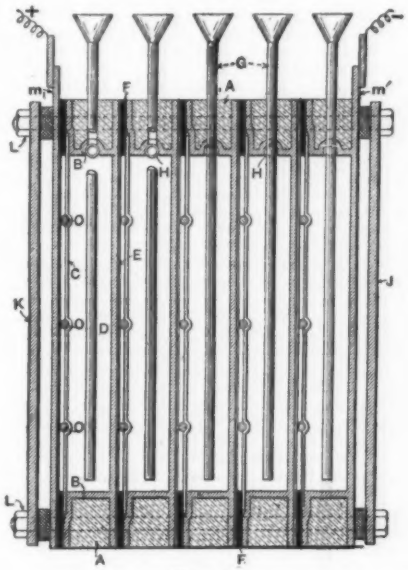

FIG. 3.

than of the type which this patent, No. 393 of 1901 condemns.

The chief feature of the cell described in this patent, and the one which gives it the greatest claim to novelty, is the use of copper wire cathodes, in place of flat cathodes of platinum or other metal. It is stated that the hydrogen gas liberated at the surface of these wires quickly detaches itself, owing to their rounded surface, and that there is less trouble experienced from coating of the cathode with a film or with bubbles of hydrogen gas than with other forms of cathode. The escape of hydrogen from the cell is therefore facilitated, and the losses due to the reducing action of this hydrogen upon hypochlorite or

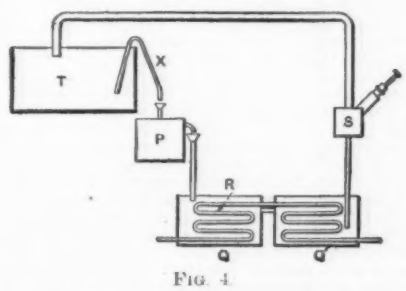

FIG. 4.

chlorate are diminished. It may be questioned, however, whether the use of copper as cathode material in a cell which necessarily contains hypochlorite as intermediate product of electrolysis is wise, and probably still more satisfactory results would be obtained with the National Electrolytic Company's cell, if platinum iridium alloy were substituted as cathode material.

The power used in the factory of the National Electrolytic Company at Niagara is obtained from the Niagara Falls Hydraulic Power Company, and is transmitted to the chlorate factory by an aluminium conductor. The original supply consisted of a 5000-ampere continuous current at 175 volts pressure. Allowing for losses in conductors and cell connections, this current would operate in series about 25 cells, or five sets similar to that shown in Fig. 3. Writing in October, 1900, the managing director of the company informed me that he expected to double the capacity and output of the works early in the present year; and in a letter dated November, 1901, he informs me that this extension of the plant was completed in February, 1901.—The Electrician.

BIRD MIGRATION AND BIRD SONG.*

BIRDS in any locality are subject to periodic migrations, going southward in the winter and northward again for the summer or nesting season, this migration being particularly well marked in the more temperate regions. Of course, there is considerable variation in this movement; a bird like the meadowlark (found in this neighborhood throughout the year) merely repairs in the winter time a little to the southward or to the warmer river valleys, where there is better food and better protection, and then scatters in the early spring all over the country through the uplands which were too cold and exposed for it during its absence. That is one sort of migration very limited in its character. The crows, which we also have with us all the year round, collect in immense congregations during the winter season and then scatter over the country in pairs at the approach of spring, their migration also being quite limited. The bobolink, on the other hand, passes through here about the first of May and goes a little to the north of this region in the northern counties of Pennsylvania; at the approach of cold weather migrating southward again, passing through here in September and extending its trip all the way to Central and even parts of South America. Some of the shore birds—the plover and sandpipers—breed in the farthest northern part of our continent on the coasts of Greenland and North America, migrating in the winter time all the way to Patagonia and Australia. That is the most extensive migration known, and this flight takes place twice a year, northward in spring and southward in autumn.

This migratory movement originated ages ago, supposedly in the glacial epoch. Every species of bird has more or less limit in its habitat: some birds are found throughout our Southern States, never occurring farther to the northward than our lowest Pennsylvania counties; others are limited to the colder regions of the earth; and in South America some are limited to an area not any larger, perhaps, than two or three of our counties. At the time of the glacial epoch the temperature all over the northern hemisphere of the world was practically the same. We find birds scattered all over what is now our colder north temperate region; and when this most northern part of the continent became uninhabitable to these birds they were driven farther southward; and as the ice melted again they pushed northward, occupying any country laid bare of this ice covering. It is supposed that the glacial epochs were several, closely following one another, and eventually were followed by the present alternation of the seasons; and that the tendency of the birds always to push north as the land was made more available for them and southward again from the increase of the cold, has resulted in this migration north and south adapted to the change of seasons now existing.

Several other causes acted to perpetuate this migration; for instance, the failure in food in cold weather. All the insectivorous birds were forced from lack of food to migrate to the southward where the temperature is sufficiently warm to keep insects alive. Then again, the failure of the supply of berries—other fruits of that sort—during winter time; of course, there were no green things of any kind occurring, and as soon as the available stock of berries and seeds was exhausted the birds were without food. Further, the habitual pushing southward and northward has become hereditary with the birds, so that in all probability to-day the birds will keep up the migration irrespective of temperature. In fact, we find the birds migrating southward in the fall long before there is sufficient cold weather to occasion this movement. All these causes acting together make this migration quite regular.

This movement naturally divides the birds of any given region into several classes. We have birds with us all the year round—merely making slight local migrations—such as the crow and meadow lark; those visiting us only in the winter time, like the snow bird, the winter wren and various other birds of that kind nesting in the colder regions to the north of us and coming thus far south to pass here the winter; then we have birds wintering to the south of us and migrating north of this latitude to breed, such as the wood thrush, winter robin and bluebird; the vast majority of our summer birds, the transients, or the birds which pass through here northward in the spring and southward during the fall but do not winter nor summer here. Many birds which are winter residents here are never found as far south as Charleston, South Carolina; and a good many birds which are transients here pass through our latitude in their migrations to breed regularly a little to the north of us; that is, they are summer residents about Cambridge, Mass., for instance.

The spring migration is much more regular than the fall. The beginning of the spring migration to-day seems to be connected very intimately with the general excitement due to the approach of the nesting season. There is a series of phenomena occurring during the early spring connected with the nesting season, such as the movement to the north I have spoken of, the breaking out into full song on the part of the birds, and their development of brilliant plumage.

A number of the members of the Delaware Valley

* From a lecture delivered at the Academy of Natural Sciences, Philadelphia.

Ornithological Club of Philadelphia made observations for several years as to the dates of arrivals and numbers of individuals of different species of birds. There were some five to six observers in the field every morning situated at various points about Philadelphia; and it was extremely interesting to see the remarkable resemblance in the charts recording the arrival of birds. Observers a little below Philadelphia about in the latitude of Chester saw the spring birds' arrival —almost all of them—a day or two before those situated immediately to the north of the city about Olney, Frankford and Germantown; and an observer situated in New Jersey a little to the east of Philadelphia always saw them earlier. It seems as if the birds spread out over the lowlands of New Jersey before they penetrated any distance above the Delaware Valley to the westward.

As to the time of arrival of our spring migrants, the beginning of migration here is represented about the 20th of February, and from then on until the 20th of May the migration continues. The height of the migration is about the first day of May to the 6th, the time at which the warblers, thrushes and various smaller birds go through. In the connection of field study of migration I have noted in the following chart my observations on the arrival of two or three of these species, observed at Germantown through the period of years from 1885 to 1892, both inclusive:

	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
April— Swift	22	23	22	20	15	22	16	27
April— B. Swallow..	22	19	22	12	22	19	19	24
May— Thrush	2	1	1	1	3	A 30	A 23	2

There are a number of other species that show the arrival almost as typically as these. The chimney swift arrives in April, on the 22d in 1885, 23d in 1886, 22d in 1887, 20th in 1888, 15th in 1889, 22d in 1890, 16th in 1891, 27th in 1892. There is comparatively little difference in the dates of arrival. I might say that the year 1891 was a remarkably early year for all the species coming under my observation; the average dates of most of the species are very much earlier than I have observed in any other season and, curiously enough, the following year, 1892, seemed to be a remarkably late year. While the general date of arrival of birds is nearly the same, we often find that an accumulation of rainy or cold days seems to retard the birds, especially during the first part of the season, and may make a very material difference in the time of arrival; and if that occurs through any considerable length of time the migration then goes on with a perfect rush and we see immense waves of birds—such numbers of them that they generally attract public attention, and you see articles in the papers comparing the immense numbers of this year as against other years, the only difference being the migration is condensed into a briefer space of time.

Sometimes in April or March we find that the temperature very materially affects migration; but at the first of May there is very little such change. The wood thrush is one of the most regular in its arrival, being audible at such long distances that there is little need for mistaking the event.

One of the most characteristic phenomena of the spring migration is the song of our birds, which, of course, sing at other seasons, but it is in the spring time we hear them at their best; and this bursting forth into full song is, like the migration and the brilliant development of the plumage, closely associated with the beginning of the nesting season. In the calls of birds we find an immense variety of notes or sounds. In the lowest birds (those which seem to be most primitive in their structure) we find song and all sorts of vocal efforts at a very low state of development. Mostly in the sea birds we have nothing but harsh cries or screams, and these are but comparatively few in number; in fact, we do not find any great variety of calls or bird notes in species lower than those which are known as the singing birds. The singing birds comprise nine-tenths of all those that you will see about any inland locality. Of course, the ducks, geese and quail—all the larger birds of lower orders—do not belong in this group; but all our familiar birds with the exception of woodpeckers, flycatchers, and chimney swifts, belong to this group. In some of the lower birds, however, we do see a considerable variety of calls, although the birds perhaps never develop what may be called a regular song; for instance, the common chicken. That is not a wild bird, but one with which we are all very closely familiar. The crowing of the rooster is an approach to the song of the higher birds; while of the great variety of clucks and call notes, each one means some distinctly different thing to the other parent bird or to the young chicken. An old hen scratching about in the ground issues one particular call intended to attract the chickens and draw them near to her; another call telling them at once that a hawk or another danger is approaching, and they immediately seek shelter; it will be found that they have quite a large vocabulary; and no doubt a majority of our wild birds have just so large a number of calls and warnings for their young, yet the difficulty of their observation is greater than that of observing domestic chickens.

"Song" is a more or less arbitrary term; all true song belongs to the group of singing birds, but there are a great many of that group which make a very poor attempt at song. This group known as the songbirds is distinguished from all others by a very peculiar structure in the throat—a strange development—a complication which enables the birds to produce the wonderful songs such as we hear in the hermit thrush, the canary and various other noted songsters. This peculiar modification of the throat is present in all the members of this group; but some of them have become more or less degenerate and have the ability to produce these notes very slightly, although the apparatus in a rudimentary form is there; so that not all those belonging to the group of singing birds are singers. The crow is one of the singing birds, having the same apparatus for singing as the wood thrush or canary; but it is not developed in anything like the same way, as the crow's efforts at song are exceedingly poor. Nevertheless, it has a very large vocabulary of calls and croaks, each one of which means something to his fellows.

The song season of birds practically begins with the beginning of the spring migration; probably at the same time that the birds feel the necessity for starting northward from their southern winter home the song season begins. In fact, we see the beginning of it here in the number of northern birds which winter with us; for instance, the snow birds, the tree sparrows, and occasionally the hermit thrush, as they pass through here in migration, will begin their songs. None of them have developed their songs to any great extent; but just as they leave us we often hear a snatch of their regular summer song which will be pretty fully developed by the time they reach their summer home. The song season lasts all through the nesting season until the young birds are leaving their nests and the old birds begin their annual moult or change of plumage. That moult is the very severe period in the bird's life, as all the feathers have to be renewed, and it is a great tax on the vitality of the bird, which loses its true song, although having a number of call notes. After the completion of the moult, about the first of August or the end of September, we often find birds resuming their songs to a certain extent. Oftentimes in the fall you will hear robins which have just resumed winter plumage preparatory to leaving for the South making a peculiar attempt at the spring song. You will recognize the difference at once. He tries to sing but lacks the ability, which fact you easily resognize. In the winter time among the birds remaining with us all through the year you find on warm, spring-like days frequent attempts at song—*e. g.*, the song sparrow. All are familiar with the characteristic song of the song sparrow in the spring and summer, and to those who hear the bird start to sing in the winter the effect is very peculiar. The bird seems to be out of breath before it has half completed its song in the winter season.

The time at which the songs of the birds are best heard is very early in the morning. After the first of May, when most of our song birds have arrived here, the early concert of these wild birds is one of the most beautiful things to be heard in nature. The birds begin to sing practically before the sun rises—four or five o'clock, and often earlier—and continue on until between five and six when the day begins to grow warm. I have heard them, especially down in the woods of New Jersey, where I have sometimes passed the nights in a small cabin, early in the morning long before the light began; such birds as the wood thrush, the ovenbird, the hermit thrush, the yellow throat, yellow breasted chat, cardinal—great quantities of our summer birds, all of them singing at the height of their ability. Of course, we hear birds singing more or less through the day time, but never to the extent as in the early morning when they are all beginning their daily practice with this chorus. In the evening just before dusk we often hear the birds again. Some of the species such as the hermit thrush, and some few birds such as the red-eyed vireo and the indigo bird, seem to sing all day long without any interruption; but the majority of species always stop their songs in the middle of the day when the temperature is at its height.

It is very interesting to compare bird songs. There is more or less family relationship between these songs. Take the songs of the thrushes in this locality —that most familiar one of the wood robin or wood thrush. A little to the north, on the tops of the higher Alleghenies or in the forests of Maine, we hear the Wilson thrush, the hermit thrust, and the olive-backed thrush—each one of them having a perfectly distinct song, but all of them having the same general sound as the wood thrush; I don't think anyone familiar with the song of the wood thrush would hesitate a minute to say, "There's a thrush, a different thrush from the wood thrush, but a thrush." I know that was my own experience without anyone to tell me when I first heard these other birds singing; I knew positively they were some of these thrushes. We notice the same thing in the case of the fly-catchers—birds which are not true song birds, but which have very distinctive calls—among them the phoebebird, the wood pewee, the great crested fly-catcher, the olive-sided fly-catcher; there is the same general quality in all these birds; the alarm notes are very strikingly similar and we find general resemblance in the calls of them all; but at the same time in other birds we find a certain amount of variation in the songs; for instance, even such a common bird as the song sparrow has perhaps half a dozen different songs. Some years ago a gentleman very much interested in the study of bird songs and who had an excellent musical ear, managed to record the musical notation of songs for a number of our birds with more or less satisfaction; and he was able to indicate some six or eight different songs for the song sparrows. Different individuals sing in different keys and with slightly different song. Of course, the general character of these songs is all the same; I think you would have no trouble in saying they were a song sparrow; but everyone has some peculiar, individual variation.

I noticed the same thing in the chestnut-sided warbler last summer while making some explorations in the higher Alleghenies of Pennsylvania, where almost all the warblers were abundant and in full song. I became very familiar with the song of the chestnut-sided warbler. It was on every hand, one of the most abundant; but one day I heard a song seeming to be something different; it reminded me of the chestnut-sided warbler, but seemed to be something else, and after a good deal of search I found it was nothing else than the ordinary chestnut-sided warbler, but one individual bird that I saw every day at a certain point and had a very decidedly different song from any of the other chestnut-sided warblers that I heard. The first part of the song was the same, but the latter part was entirely distinct. We see that same thing in the case of the meadow lark. You will frequently see in books on birds that the Eastern meadow lark and the Western meadow lark, while scarcely different in plumage, have totally different songs. This is true, because the song of the Western bird is a beautiful extended song, while the call of the Eastern bird is simply that phrase resembling the words, "Can't see me!" Careful observations in various parts of the country show that the song of our Eastern birds is not the same throughout its range; the song is decidedly different; and if you get out to the Mississippi Valley you find that the song is decidedly different there; and when you get out into the Western plains, you find that the meadow lark has a very different song in California. A recent observer has said he does not think two Western meadow larks sing exactly alike; and so we have in the case of the Western meadow larks a wonderful variation of song. These may be points in the evolution of song, changing from one song to another.

In such birds as the Carolina wren and the mocking bird we find another interesting point; that is, the ability to mimic or imitate the notes of other birds. The mocking bird, of course, is pre-eminent in this peculiarity and learns to imitate the notes of quite a number of species. This brings us to a very interesting point in the discussion of songs; that is, the probable mimicry in bird song on a very large scale. Some writers have gone so far as to claim that the whole origin of the various kinds of song that we find in our birds is a matter of mimicry. I am not prepared to say just how much truth there is in this; but certainly there is some very strong ground for this belief. We find in the case of the Carolina wren, of which I spoke, the cardinal bird, and the crested titmouse, three birds whose notes are very strikingly similar. They have precisely the same range; for everyone of them is found in the same locality with the others; and this peculiar observation certainly requires some explanation. Perhaps one or other of these birds has mimicked one of the other species. The mimicking of bird songs is not really a very surprising matter, because if we go to the cry of alarm, we find that the alarm cry of one bird serves just as well to alarm a half-dozen more species which may be in the neighborhood. If one peculiar cry should become to be generally recognized as a cry of alarm, it is not at all surprising that other associated birds should imitate that call if they wish to represent the same thing. We have some striking instances of resemblance in bird songs—*e. g.*, the grasshopper sparrow and the Savannah sparrow, both of which are found in tall grass, in just such situations as various species of grasshopper producing just exactly the same character of notes as these birds. Anyone hearing one of these species would think it nothing more than the notes of one of our larger grasshoppers or crickets. Another instance is the cry of the night heron, almost exactly like the croaking of our frogs found in the same spots inhabited by the heron.

The study of bird song has been very much neglected. We have practically no careful treatise on the subject. We know perhaps only a few of the songs of our birds. A majority of the commoner species are familiar to us; but almost all our birds have some peculiar songs and cries we only hear once in awhile and none, perhaps, out of the thousands of observers, have ever heard all the calls of even our common species.

The birds which breed through the eastern half of North America migrate southward to the east of the Alleghenies, along the coast down to Florida, and then across to the Bahamas, West Indies, and around the curve of the Lesser Antilles into South America. The Western birds, on the other hand, migrate in another direction, along the coast of Mexico and down into South America by the Pacific; so that in South America we find North American birds which cross on both sides. Such birds as the bobolink have been taken in South America down almost to the edge of Uruguay. As I explained before, some of the plover and sandpipers breeding on the coast of Greenland migrate down to Patagonia in winter. In their migration birds follow some coast line, as a rule, or else some chain of islands; but occasionally they strike boldly out over large areas of water; for instance, some of the sandpipers breeding on the Aleutian Islands come down regularly to the Hawaiian Islands and down to the islands of the Central Pacific, passing over an immense stretch of ocean, but getting there regularly every year. We also find birds regularly on the Bermuda Islands, but not in very large numbers; and in all probability those birds have been blown out to sea in the course of their migrations.

There is one point on the Mediterranean where birds migrating from their winter quarters in Africa annually into Europe strike right out into open sea and across the Mediterranean. They always leave the land at the same point and arrive on the other side at the same point; and geological evidence shows at one time there was a string of islands probably connected right across that point. In all probability they have been migrating over that route before this land was entirely submerged, and the hereditary impulse to take that course has been perpetuated and passed on to their young so that they strike now right out into the open ocean.

There are some forty or fifty species of birds that are found in the vicinity of Philadelphia probably every winter season. Of course, you cannot see all of those birds in one trip; probably an acute observer in New Jersey might be able to see twenty species in the winter; in Pennsylvania, not more than ten or twelve. As an actual experiment, a number of ornithologists in the neighborhood of Philadelphia tried to see how many birds they could identify during several days of Christmas week, 1900. Several lists were made, and the numbers of birds in the immediate vicinity of Philadelphia ranged from eight to twelve; in New Jersey one observer saw on the Saturday following Christmas seventeen species. That is a very fair list for midwinter. There were some eight or ten others that certainly could have been found in New Jersey, probably only a few miles off; but in an ordinary walk ten or fifteen birds in winter-time is a very fair number.

Around Philadelphia all through the winter-time except on some warm, spring-like days the song sparrow is quiet. He begins his song whenever the weather gets warm; and those who are afield in the winter-time frequently hear him attempting a spring song; but by the last week of February or the first of March the song sparrow begins to sing regularly, and quite a

number of people think that he is one of our spring arrivals from the South, though as a matter of fact he has been with us all the time. His song, however, is one of the first indications of spring bird-life. I remember one instance of finding a song sparrow's nest in April with some eggs in it and the next day the ground was covered with snow, which did not last long and probably did no serious damage to the nest.

The flicker, or golden-winged woodpecker, is an interesting bird with regard to his notes. Belonging to one of the groups further down the scale than the true song birds, he of course has not any true song; but he has a long, rapid cry—a number of notes in just about the same pitch and repeated after one another very rapidly, performing the same service as the calls of the higher birds. Then he has a peculiar alarm cry which has given rise to the popular name, "yarrup," and he has also another peculiar note which you frequently hear when two flickers are pursuing one another around through the branches of trees. The male and female flickers, while otherwise alike, can be told by the dark stripe on the side of the face of the male and its absence in the female. That is found in the young birds immediately after they leave the nest.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Gas Coal in Italy.—A recent demonstration of new gas lighting in this city brought out several points of interest to American coal exporters and also to manufacturers of gas-burners and lamp supplies. One of the gas companies in this city decorated the leading avenue in the Valentino Park (in which the Exposition of Modern Decorative Arts is in progress) with Welsbach lamps. The exhibit aroused wide admiration. Gas is furnished to consumers here at a certain price, governed to an extent by the cost of standard coal—called the "New Pelton"—in England. The price now charged is 5.75 lire (about $1.10) per 1000 cubic feet, which is lower than that in almost any city of Italy.

Until about two years ago, American coal was scarcely known in Italy. A cargo was then imported into this city, and it proved so satisfactory that the local gas companies during the past year purchased some 25,000 tons. They claim that the American coal possesses more volatile matter than any other coal and that it makes better and more gas, and have issued an official statement to that effect.

The great distance is the only drawback to the use of our coal in this market. I am informed that the gas companies paid as much as $1 per ton extra for the American coal that they have employed, and that if the difference were only 30 cents per ton, they would prefer it to all others.

Not only did this illumination develop the fact that American coal makes better gas than that produced in England, but it also showed that the globes, mantels, burners, etc., were mostly supplied by American manufacturers.

I may note in this connection that I have seen many articles of American origin in this city such as sewing machines, cash registers, bicycles, sausage grinders, lawn mowers, typewriting machines, tools and machinery, but I have not seen a single revolving office chair of American or any other make.—Pietro Cuneo, Consul at Turin.

German Duty on Mineral Oil for Motors.—Consul J. J. Langer sends the following from Solingen, June 6, 1902:

The chambers of commerce at Nuremberg and at Solingen have petitioned the federal council to place mineral oil used for motor power on the free list of importations. In the Solingen cutlery industry, home work is still a prominent factor. Among these people and the middle class of manufacturers, the use of motors has greatly increased in the last few years, and the entry of mineral oil free of duty would be of the greatest benefit for them, especially in view of the high price of coal at this time.

German Agricultural Exposition.—The sixteenth annual exposition of the German Agricultural Society has just closed at Mannheim. As at previous exhibitions given by the society in other parts of Germany, live stock and agricultural implements formed the chief exhibits.

In machinery and farming implements, the displays were for the most part excellent and embraced a wide variety. Every leading manufacturer of harvesting machinery in the United States was represented, with from ten to twenty machines. A Toronto company had a large and well-selected exhibit. Two or three English manufacturers and the same number of German firms had displays. Many of the machines were kept in motion. In this class the American exhibits were far in the lead and attracted much attention. The same was true of hayrakes, tedders, cultivators and other lighter implements.

Many threshers and portable engines were exhibited, all of German make, except a small French separator with a gasoline motor. The threshers meet the requirements of the German farmer that the straw shall be broken as little as possible, which practically excludes the ordinary type of American thresher.

As far as noted, but one exhibit of American plows was made. This would seem to show a want of interest on the part of our plow manufacturers. The explanation is to be found mainly in the persistency with which the German farmer clings to a type of plow which is not used in the United States. It is heavy, poorly shaped, and has a pair of wheels from 16 to 18 inches in diameter, supporting the front end of the beam. The native plows exhibited were all of this pattern. It would seem that an easy-running American plow, a trifle heavier than the ordinary one-horse apparatus, and fitted, if possible, with a point that could be dressed by a blacksmith, should become popular in the mellow soil so common in many parts of the empire. The local agent would have to be thoroughly competent to teach the use of the American plow, and it should be sold cheaper than the cumbersome native implement (because simpler in construction) and should prove far more satisfactory.

Other German farm machinery seems heavy and clumsy compared with the American. Parts on which there is little or no strain are made unnecessarily strong. This tendency appears in hayrakes, grain drills, mowers, tedders, shovel plows, weeders, harrows, etc., and reflects the German idea that an implement should not only do the work but give evidence of lasting qualities. In the United States, the man who pays for the harvester or mower is likely to be the man who drives it or sees that it is driven properly and kept in good condition. In Germany, especially on the larger farms, the machine is sure to go into the hands of a hired man, who may be exceedingly careless in its use. Prizes were awarded at this exposition to machinery which would under no circumstances be used by an American farmer, because of the heavy draft upon his team.

In farm wagons, also, the exhibit displayed the prejudice in favor of heavy, cumbersome implements. It would seem that with the excellent public roads in Germany, the American farm wagon, if made of good material and well ironed and supplied with a 3-inch tire, should become popular. Undoubtedly, the wood used by the German wagon maker is much inferior to that employed in the United States and accounts to a degree for the larger size of the parts. The brakes on most of the wagons operate by a crank at the rear end, attached to the coupling pole.

Taken as a whole, the exposition showed the awakening interest in better farming appliances in Germany. In many parts of the grounds were improved pumps and spraying apparatus, milk cans and churns, apparatus for cooking feed for stock by steam, improved scales for various purposes, etc. Many of these appliances are constructed along distinctly modern lines and clearly indicate the trend of German manufacture in this important field.—H. W. Harris, Consul at Mannheim.

American Coal and the French Market.—The fact that much of the fuel used in France has to be imported, at an exceedingly high price, has led the French to make minute calculations of the relative value of the various combustibles they employ. In some localities, there is a strong conservatism which opposes the use of any product unknown in a practical way. The result is that our coal has been looked upon with more or less suspicion and many unfavorable prejudices have been created (1) by first appearances, due to the ignorance of our exporters as to the needs of the French market; (2) by analyses which, theoretically, showed a too small percentage of carbon and too much volatile matter, judging from experience with European coals.

It has been found in practice, however, that to some degree appearances were deceptive and the theory incorrect, as shown by the opinions of seven persons as to the quality of American coal. These persons are either highly connected with railway lines or with large manufacturing concerns which have burned American coal. The first claimed that it was inferior in caloric force, as compared with newly mined South Wales coal; the second, that he found the combustion in the grates of his factory too rapid; the third, that the lumps fell to pieces when touched by the stoker (he admitted that his men may not have made the most of it, as they were not accustomed to such coal); the fourth declared that the coal was too friable; the fifth stated that for locomotives, other conditions being equal, there was no noticeable difference between the samples of American coal tried by him and the best Cardiff; the sixth was persuaded that this coal could easily replace the best Welsh; while the seventh person had learned that American fine coal was worth 10 per cent more than Cardiff "menu," because it did not run to fine dust when broken, but consisted largely of particles the size of pease.

The French classification of coal used here is as follows:

(1) "Tout venant" ("run of mine" or "through and through"). To the French purchaser, the signification is not the same as to the American seller; it means here coal that contains not more than 30 per cent of fine.

(2) "Menu" (fine coal), which contains 30 per cent of lumps. The rest consists of dust and particles small enough to pass through a mesh of 25 millimeters (0.98 inch).

American coal, on its arrival in France, has usually been so badly broken as to contain as high as 85 per cent of fine. This places our coal on a par with Cardiff menu, so far as the proportion of lumps is concerned.

The prices are determined by classification and quality. As the general opinion of the railroads is that the quality is of the best, there remains only the question of classification. One railroad officer writes me that "the price should not exceed at any time that of Cardiff coal, quality being equal."

If our mine owners are content to sell their coals as menu in France, they can easily secure the market, but the buying price is low. One railroad official tells me that his company recently purchased 115,000 tons of menu at 15.50 francs ($2.99) the ton, delivered in cars alongside and duty—1.30 francs (25 cents)—paid by the sellers. These people could have paid 17 francs ($3.28) for American menu under the same conditions.

Should our exporters wish to sell coal with 70 per cent large, they may be governed in price by the current value of best Cardiff.

The following conditions will usually fulfill the requirements of any French railway contract:

Water	1 per cent
Volatile matter:	
Minimum	18 per cent
Maximum	24 per cent
Ash	9 per cent
Caloric force (minimum)	8,000 calories

As to consistency, the coal should contain on delivery at destination not more than 30 per cent menu, it being understood that all that passes through a sieve with holes 25 millimeters (0.98 inch) in diameter is menu.

Cardiff coal fulfilling the above conditions has recently been sold here, duty paid by the sellers, delivered on cars alongside, for 21.40 francs ($4.13) the ton of 2,205 pounds.

The uses of bituminous coal in France should also serve as a guide to the American exporter. For domestic purposes, the coal should not be too friable, as the necessary handling produces much dust and consequent loss; neither should it be too bituminous, on account of the smell and smoke.

For the manufacturer of gas, the requirements are practically the same as in the United States, except, perhaps, that more stress is laid on the necessity for a large amount of coke. Large quantities of coal are consumed in factories in this part of France. Two important consumers say that under existing conditions American coal is worth about 10 per cent less than the best Cardiff. How far this deficiency in value may be due to grates adapted to burning a coal with a greater per cent of carbon and of a slower combustion than the American coal tried here, is a question which it may pay our exporters to investigate.

In the ships that visit ports south of Havre, there seems to be very little difficulty in obtaining good results from our coal. This may be due in part to the construction of the furnaces and in part to the experience of the stokers in using various kinds of coal.

The railways are the most important consumers. The three lines nearest La Rochelle burn nearly 700,000 tons per year. This immediate district receives 650,000 tons annually, of which 225,000 tons are burned on the railroads. I am led to believe that this proportion also holds for the ports of St. Nazaire and Nantes.

To meet the requirements of the French trade, the following suggestions are made: Can American (1) procure cheaper transport? (2) should they not sift certain coals? (3) should they not improve the loading apparatus, so that the coal be not broken in putting it into the hold? (4) should they not use their coal dust to make briquettes, which sell here for from 27 to 32 francs ($5.21 to $6.17) per ton?—George H. Jackson, Consul at La Rochelle.

American Lumber in Rotterdam.—The wood exported from the United States to the Netherlands consists principally of pitch pine, timber and lumber; also hardwood logs, such as walnut, poplar, oak, hickory and ash.

Poplar logs are continually in good demand, and fresh sound logs of 28 inches and upward always find buyers upon arrival. The price obtainable at present is $44 to $46, and for logs of 22 inches and upward, $38 to $40. Quotations for logs are per 1,000 feet Scribner, and for lumber per 1,000 square feet, ex quay.

Black walnut logs are, after poplar logs, the American hardwood most used here. The market for this kind of logs is strong and in good condition, and stocks are exhausted. Prices vary from $80 to $120, according to quality and size. The best-selling logs are 18 inches and upward, to average 22 to 24 inches, good, sound quality. Veneer logs are not wanted.

White oak logs, 24 inches and upward, will realize $45 to $47. Hickory logs are in fair demand, and prime logs 14 inches and up will bring about $60 at present. Stocks are all cleared.

Persimmons seem to have gone entirely out of demand; the stock is about 80 tons.

White ash logs, 16 inches and upward, sell for $44 to $45; gum logs, 24 inches and upward, about $38 to $40; the demand is limited.

The present quotations for lumber are: White oak, plain sawed, first and second grade, 1 inch to 4 inches, $45 to $52; white oak strips, 1 by 4 to 6 inches, $38 (the demand is very limited); oak scantlings, 2½ by 2½ to 4 by 4 inches, 6 to 16 feet, $45; satin walnut (in good demand), 1 inch, $42; 1¼ to 1½ inches, $43 to $44; 1¾ to 3 inches, $45 to $46.

For black walnut lumber, there are few buyers; quotations are, for 1 to 4 inches—$105 to $125.

Cottonwood is in active demand; quotations are: One inch, $28; 1¼ to 1½ inches, $29 to $30; 2 inches, $31.

Ash lumber, 1 to 3 inches, sells for $42 to $48; whitewood lumber, 1 to 3 inches, $42 to $50.

Pitch pine always sells readily in any quantity; prices at present obtainable are £13 10s. ($65.69) to £14 ($68.13) per standard.

Floorings, 1 by 6 inches, sell for £12 10s. ($60.79).

The above quotations are the average prices at this date, obtained from various dealers in logs and lumber at Rotterdam. It should be observed, however, that it is a somewhat difficult matter to name ruling prices, as much depends on stocks on hand, arrivals and demands at a given time. Consuls are sometimes blamed for sending too flattering reports, when the fact is that at the time reports are made, the stocks on hand are low and prices correspondingly high. By the time American shippers get their wares into the European markets, it is possible that large supplies may have arrived, and that prices are correspondingly lower.—S. Listoe, Consul at Rotterdam.

Demand at Harput for Hardware, Etc.—During the past few months, there have been special demands at this consulate for catalogues, price lists and general information concerning the several classes of manufactured articles enumerated below.

There are marked indications of excellent openings for American wares in these different lines, resulting from dissatisfaction with the quality of the articles imported from Europe and the high grade of similar objects brought from America by the members of the resident American colony. Several firms in Mezreh and in Harput are desirous of accepting agencies and pushing energetically the American wares.

Agents' terms, accompanied by detailed, illustrated price lists, are requested. They can be sent to this consulate—post office address, Mezreh, Mamouret-ul-Aziz, Turkey in Asia.

Hardware.—All the ordinary forms of hardware are in demand here. Structural hardware, screws, hinges, door catches, etc., come chiefly from Germany. They are of a decidedly inferior grade. Cutlery is almost invariably of poor steel. Knives come chiefly from England; scissors, from Germany.

Tools.—There is a similar lack in the quality of the tools manufactured or brought here. Artisans and mechanics frequently express a desire for light,

handy, strong tools, similar to those which occasionally find their way here from the United States. The tools necessary for repairing cotton gins would find a ready sale.

Lathes.—A few lathes for metal work have been imported from Europe, but fail to give good satisfaction. Several inquiries have been made for American lathes.

Bedsteads.—The population is coming more and more to use iron and, occasionally, brass bedsteads. A clumsy article is manufactured here, and a better grade is imported from Austria and Germany. There is a distinct opening for light, strong bedsteads, which can be packed compactly and imported at a minimum of expense for freight.

Lamps.—The use of petroleum is becoming more and more widespread, not only in the cities, but in the outlying villages. Lamps of metal are in steady demand. The bulk of the imports is from Germany. The lightness and convenient adjustment of our lamps, however, invariably commend themselves to those who have had the opportunity to become acquainted with them.

Enameled Ware.—The use of agate and granite ware for the kitchen and the household in general is steadily increasing. There is, however, a marked dissatisfaction with the poor grade of coating on the utensils of European make brought here, and the very limited service which they render. Enameled vessels of much size are totally lacking in these markets. The native population continues to use the rather costly old-fashioned copper kettles.

Toys.—The cheap German and Swiss toys brought here find a ready sale, as native families show much fondness for children. Inquiries are made, however, for the more tasteful and durable toys of American make. Those of rubber or metal construction would be in especial demand.

This consulate will gladly facilitate the efforts of manufacturers in the above lines.—Thomas H. Norton, Consul at Harput.

Trade Notes from Cyprus.—Cyprus has once more a direct weekly steamship service to Egypt via Port Said. American exporters dispatching goods to Cyprus may forward them via the new American-Levant steamers to Alexandria, to be transshipped at the latter point for Larnaca, Limassol, Famagusta or other Cypriote points.

Tenders are invited for the construction of the Famagusta harbor works and a railway between Larnaca, Famagusta and Nicosia. For this purpose, £350,000 ($1,701,000) are available. The harbor is designed to admit the largest steamers trading in the Levant. Cyprus needs a commodious, protected harbor.

In his speech to the legislative council at the opening of the present session, the high commissioner urged conservation of existing water supplies, and said that the government was considering the opening of artesian wells.

Further improvements since my last report on this island* are observed in tree planting, in the construction of roads, in sanitary measures, in the development of the wine and silk industries, and in the negotiations for the establishment of an agricultural bank.

It is worth noting that a growing number of the young men of Cyprus attend the American college at Beirut, some of them being students in its school of commerce.

The exports of the Island of Cyprus for the year ended December 31, 1901, amounted (less specie) to $1,555,600 and the imports during the same period (less specie) to $1,820,400, showing a small decline in both exports and imports, but more particularly in the export trade, due to last year's drought.

During the year, a Larnaca firm made efforts to establish connections with American exporters, and the correspondence will probably lead to some business in agricultural implements, irrigation machinery, windmills, iron and steel, hardware, wire nails, cotton drills, leather, wheat and wheat flour, and canned provisions, while skins, wool, and cigarettes are likely to be shipped from Cyprus to the United States.—G. Bie Ravndal, Consul at Beirut.

American Vines in Bulgaria.—Consul F. D. Chester writes from Budapest, June 22, 1902, that according to the official horticultural paper of Hungary, the Bulgarian Minister of Commerce and Agriculture has forbidden the importation of American grapevines, a large quantity of which had been brought from Hungary into the district of Viddin, Bulgaria.

United States Goods in Canada.—Under date of July 4, 1902, Commercial Agent J. E. Hamilton writes from Cornwall:

The demand for American goods is increasing in Canada; hardware, brass goods, agricultural and farming implements, ladies' novelties, boots, shoes, and hats are especially popular, and goods are advertised as American in order to win patronage. No license is required in Ontario for commercial men or drummers, and samples are duty free.

*See Advance Sheets No. 1099 (July 29, 1901); Consular Reports No. 253.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1391, July 14.—French Currant Wine—*Demand at Harput for Hardware, etc.—Commerce of Mosul—Canadian Machine for Laying Brick—Mica Plant in Ottawa.

No. 1392, July 15.—Need of Direct Steamship Line to the West Coast of Africa—Trade of the Peloponnesus—Finances of Guatemala—Completion of Railway in Nicaragua.

No. 1393, July 16.—The Cape to Cairo Railway—*Trade Notes from Cyprus—Foreign Trade of Denmark in 1901—New Material for Plastic Art.

No. 1394, July 17.—German Meat Imports under the New Inspection System—Persian Textile Monopoly—American Coal in Denmark—Exhibition of Fishery at St. Petersburg.

No. 1395, July 18.—*Trade Conditions in South Africa—Admission to Italian Art Galleries—*Meats and Dairy Products in New Zealand—*United States Goods in Canada—Third and Fourth Class Postal Rates in Canada.

No. 1396, July 19.—Notes for Travelers over the Siberian Railroad—*Free Imports into Yucatan.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

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